LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

BRITISH MUSEUM (NATURAL HISTORY)

THE

JOHN MURRAY EXPEDITION 1933–34

SCIENTIFIC REPORTS

VOLUME V. No. 3

CRUSTACEA: PENÆIDÆ

BY

M. M. RAMADAN, PH.D.(CANTAB.)

WITH FIFTEEN TEXT-FIGURES

LONDON:
PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM
SOLD BY
B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1; DULAU & CO., LTD., 29 DOVER STREET, LONDON, W.1; OXFORD UNIVERSITY PRESS, WARWICK SQUARE, LONDON, E.C.4; H.M. STATIONERY OFFICE, LONDON, S.W.1
AND AT
THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7
1938

[*All rights reserved*]

Price Two Shillings and Sixpence

[*Issued 26th March*, 1938]

DESIGNED AND
PRINTED
BY
ADLARD & SON, LTD.
17 44
21, HART STREET, W.C.
AT
BARTHOLOMEW PRESS
DORKING

Made and printed in Great Britain

LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

CRUSTACEA: PENÆIDÆ

BY

M. M. RAMADAN, PH.D.(CANTAB.).

WITH FIFTEEN TEXT-FIGURES.

INTRODUCTION.

THE material upon which this report is based is primarily the Penæidæ collected by the John Murray Expedition, but I have also examined a number of Penæidæ in the collection of the British Museum, material obtained by the German Deep-Sea Expedition, and other specimens mentioned below. Of the subfamily Aristæinæ, the genera *Benthesicymus* and *Gennadas* are not included in this report, as they will be the subject of a separate report by another author.

I am greatly indebted to Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., for the opportunity of examining this interesting collection, and for securing for me, for examination, specimens of *Aristeus alcocki* (= *Aristeus semidentatus* of Alcock) from the Indian Museum. I wish to express my thanks and gratitude to Dr. W. T. Calman, F.R.S., Keeper of the Zoological Department in the British Museum, for the opportunity of working in his Department, and to Miss I. Gordon, D.Sc., for her help during my work there and for securing for my examination several specimens from other Museums. I also desire to acknowledge my indebtedness to Prof. H. Balss, of the München Museum, for the loan of two specimens of *Aristeus semidentatus*, collected by the German Deep-Sea Expedition; to Dr. J. Richard, Director of the Monaco Museum, for the loan of a specimen of *Aristeus antennatus* collected by the Prince of Monaco; to Mr. M. D. Burkenroad, of the Peabody Museum of Natural History, Yale, for his unfailing courtesy in answering my correspondence; to Dr. Schellenberg, of the Zoologisches Museum der Universität, Berlin, for the provision of facilities for work during my visit to the museum, and for the loan of five specimens of *Aristeus semidentatus* collected by the German Deep-Sea Expedition; and to Mr. Fenner A. Chase, jun., of the Museum of Comparative Zoology, Harvard, for examining for me some material in that Museum.

Finally, I wish to express my grateful thanks to Prof. J. S. Gardiner, F.R.S., in whose laboratory the work was done; and to Dr. L. A. Borradaile for his valuable help and for the great pains he has taken in reading through the text.

List of the Species.

Aristeus alcocki sp. nov.
A. antennatus (Risso).
A. mabahissæ sp. nov.
A. virilis (Spence Bate).
Hemipenæus carpenteri Wood-Mason.
H. crassipes Wood-Mason.
Plesiopenæus armatus (Spence Bate).
Aristeomorpha foliacea (Risso).
P. edwardisianus (Johnson).
Aristeomorpha sp.
Hepomadus tener Smith.
Solenocera hextii Wood-Mason.
S. rathbuni nom. nov.
Hymenopenæus propinquus (De Man).
H. lucassii (Spence Bate).
H. sewelli sp. nov.
H. fattahi sp. nov.
Penæus indicus Edwards.
P. marginatus Randall.
Trachypenæus curvirostris (Stimpson).
Funchalia woodwardi Johnson.
Pelagopenæus balboæ (Faxon).
Penæopsis rectacutus (Spence Bate).
P. coniger (Wood-Mason).
P. serratus (Spence Bate).
P. philipii (Spence Bate).
P. vaillanti Nobili.
P. faouzii sp. nov.
Parapenæus fissurus (Spence Bate).
P. investigatoris Alcock & Anderson.
P. murrayi sp. nov.
Eusicyonia carinata (Olivier).

Subfamily Aristæinæ.

The Aristæinæ comprises two series, the Benthesicymæ and the Aristeæ. The former is characterized by the excessive development of the distal filamentous portion of the superior antennular ramus. The collection of the Benthesicymæ of the Expedition will be reported on by another hand.

Key to the Genera of the Aristeæ.

(Modified from that of Alcock, 1901, pp. 12–13.)

1. No hepatic spine on the carapace.
   - A. A well-developed podobranch on the 3rd legs and well-developed epipodite on the 4th leg . . . . . *Plesiopenæus.*
   - B. The podobranch on the 3rd leg and the epipodite on the 4th leg are usually absent, and, if present, are very reduced.
     - *a.* Cervical groove indistinct; no podobranch on the 3rd leg, no epipodite on the 4th leg, no exopodites on the legs . . . . . *Aristeus.*
     - *b.* Cervical groove distinct; podobranch on the 3rd leg, epipodite on the 4th leg and exopodites on the legs may be present though reduced . . . . . *Hemipeneus.*
2. An hepatic spine on the carapace.
   - A. A well-developed podobranch on the 3rd leg and a well-developed epipodite on the 4th leg. Rostrum armed with more than 3 teeth . . . . . *Aristeomorpha.*
   - B. The podobranch on the 3rd leg and the epipodite on the 4th leg, if present, are very reduced; rostrum armed with 3 teeth . . . . . *Hepomadus.*

Genus *Aristeus* Duv.

Aristeus, Alcock, 1901, p. 29; Bouvier, 1908, p. 69; De Man, 1911, pp. 6 and 27; Balss, 1925, p. 224.

This genus comprises seven, or perhaps eight, species, of which one is new and one is here established for material already known. These species are:

A. antennatus Risso.
A. antillensis Bouvier.

A. occidentalis Faxon.

A. semidentatus Spence Bate, 1888, and de Man, 1911 ; *nec A. semidentatus* Alcock, 1901 ; *A. semidentatus* Kemp & Sewell, 1912 ; Balss, 1925.

A. virilis (Spence Bate) (= *A. tomentosus* (Spence Bate) and *A. semidentatus* Balss, 1925, in part).

A. alcocki sp. nov. (= *A. semidentatus* Alcock, 1901 ; Kemp & Sewell, 1912).

A. mabahissæ sp. nov. (= *A. semidentatus* Balss, 1925, in part).

A. japonicus Yokoya ?.

It is very doubtful whether *A. japonicus* is really an *Aristeus*. Yokoya's figure (1933, p. 3) shows a hepatic spine on the carapace and more than three teeth on the rostrum ; both these characters are diagnostic of the genus *Aristeomorpha* and never occur in *Aristeus*. The key given by Bouvier (1908, p. 70) for *Aristeus* is not quite correct. The presence of a spine on the posterior edge of the 3rd abdominal segment has not the value given to it in the key, as its presence or absence is due to individual variation. Similar spines have been found in some specimens of *A. alcocki* and *A. mabahissæ*, as will be seen later. The post-rostral carina extends beyond the gastric region, contrary to Bouvier, not only in *A. antennatus*, but in all the other species examined by me, though it is very faint beyond the gastric region. Although in *A. antennatus* it is more conspicuous in the region referred to than in the rest of the species, this slight difference cannot be relied on in identification unless specimens of *A. antennatus* are available for comparison. The utilization of the nature of the pleurobranchiæ in advance of segment XIV as a specific character by Bouvier (1908, 1909) is very misleading. Faxon's description of the pleurobranchiæ on the segments in advance of segment XIV in *A. occidentalis* is not exact, as will be shown below. Again, when Alcock described these pleurobranchiæ in *A. semidentatus* as minute filaments with no pinnules, he was in error, as he was dealing with a species (*A. alcocki*) other than *A. semidentatus*.

I have seen specimens of all the species of this genus except *A. antillensis*. Most of the characters given by Bouvier (1909) as separating the latter species from *A. antennatus* are of doubtful value. Some of them, as I have shown under *Plesiopenæus armatus*, must be due to intra-specific variation. If Bouvier's statement (1909, p. 203) regarding the measurements of the segments of the 3rd legs is correct, this species would be easily separated from the rest of the species by having the carpus of the 3rd leg as long as the corresponding merus ; but* this must be admitted with some reservation, since a similar statement by Bouvier concerning another species has proved to be incorrect. Although the relative lengths of the leg segments are commonly used as one of the characters by which species of this genus can be separated from each other, yet these measurements, *per se*, cannot be considered a good specific character, as work on certain other prawns (*e. g. Palæmon carcinus*) has shown that the relative lengths of the leg segments vary with age. Unfortunately the available specimens of the different species of this genus are not of graded sizes, so a study of the growth changes of the relative lengths of the legs could not be made ; but from a study of the measurements of the legs of all the specimens available of *A. virilis*, *A. alcocki* and *A. mabahissæ*, which species can be easily separated from each other by a number of characters mentioned below, I have reached the conclusion

* Under *A. antennatus*, Bouvier (1908, p. 72) states that the chela of the 3rd leg is as long as the corresponding carpus. On examination of one of the specimens examined by him (see below under *A. antennatus*) that was found not to be true.

that in *adult* specimens of this genus the relative length measurements of the leg segments are constant for each species and are different from those of other species. On this basis the relative length measurements were made use of in order to distinguish *A. antennatus*, of which no male specimens are available. In a specimen of *A. virilis* (180 mm. long) the merus of the 5th leg is 22 mm. long and the carpus is 23 mm. ; in a specimen of *A. mabahissæ* (180 mm.) these two segments measure 24 mm. and 24 mm. respectively ; while in a smaller specimen of *A. antennatus* (160 mm.) these two segments measure 19 mm. and 26 mm. It will be noticed that in the last specimen, which is smaller than the specimens of *A. virilis* and *A. mabahissæ*, the carpus is longer than in the two specimens of the two latter species. *A. virilis* is easily distinguished by the tomentum on the body and legs, and by having a movable spine on the merus of the three anterior legs. *A. alcocki* is separated by the pleurobranchiæ in advance of segment XIV being the merest papillæ with no pinnules at all, and by the position of the anterior part of the branchio-hepatic groove. The rest of the species can be separated by the relative lengths of the leg segments, as will be seen below under the accounts of individual species.

De Man (1911, p. 36) writes regarding *A. semidentatus* Spence Bate : " This species is very closely related to *A. occidentalis* Faxon from the Galapagos Islands, but in this form the pleurobranchiæ of the somites X–XIII should bear no pinnules at all." I would note here that the description of *A. occidentalis* given by Faxon is, in this respect, not correct. I have examined a female specimen of this species from the Galapagos Islands in the collection of the Museum of Comparative Zoology, Harvard, and I found that the pleurobranchiæ referred to are as well developed as in examples of *A. semidentatus* obtained by the "Challenger" and the "Siboga". These pleurobranchiæ, although much smaller than those on the 14th somite, yet carry many pinnules, and in some of the " Challenger " specimens they carry about 15 on either side. *A. occidentalis* and *A. semidentatus* do not differ in the relative length measurements of the three anterior legs. The 4th legs of the specimen of *A. occidentalis* were missing, and the 5th legs were missing in all the specimens of *A. semidentatus* examined. An exact comparison could not therefore be made ; but I would note here that the inner edge of the merus of the 1st leg of the male of *A. semidentatus* (" Siboga " specimen) is concave. Mr. Fenner A. Chase, jun., of the Museum of Comparative Zoology at Harvard, who examined for me the male specimen of *A. occidentalis*, writes : " The merus of the 1st leg is perfectly straight, so that I would hesitate to call it even slightly concave." On this account I am inclined at the moment to consider *A. occidentalis* to be a separate species from *A. semidentatus*. The inner antennular flagellum of the male of *A. occidentalis*, according to the description and a figure by Mr. Chase, is concave for some distance on the inner side and not flattened as in *A. virilis* or *A. mabahissæ* (Text-fig. 4 *c*). The inner antennular flagellum was missing in the male specimen from the "Siboga" Collection. In all the specimens of the genus examined by me a movable spinule was found to exist on the anterior part of the meri of the 1st and 2nd legs and on the first three legs in *A. virilis*. Although I have not seen specimens of *A. antillensis*, these spinules are probably possessed by it, judging by the constancy of their occurrence in all other species.

Distribution.—*A. occidentalis*, Pacific (off Central America) ; *A. antillensis*, Sea of the Antilles ; *A. antennatus* has the widest distributional range of all the species of the genus—Mediterranean, East Atlantic and Indo-Pacific. The greatest depth at which this genus has been observed is 1400 metres (*A. antennatus*). The vertical distribution is

variable : *A. antennatus* has been taken at depths between 200 and 1400 m. and *A. alcocki* between 270–360 m., and 1051 m.

Aristeus virilis (Spence Bate).

Aristeus virilis, Spence Bate, 1888, p. 303, pl. 44, fig. 4, Alcock, 1901, p. 30.
Aristeus semidentatus, Balss, 1925, p. 224, in part.

Occurrence.—Sta. 115, Zanzibar area, depth 640–658 m. ; 1 female.

The specimen is 180 mm. long, with the spermatophores intact. To the description of previous authors I may add that the merus of each of the first three legs possesses a movable spinule on the anterior part. These spinules were found to be present in the " Challenger " specimens and in two specimens from the Indian Museum. In the other species of the genus they are present on the first two legs only. This species is easily distinguished from the other species of the genus by the pubescence of the body, the possession of movable spinules on the first three legs and the relative length measurements of the legs. Besides these differences, the males are distinguished from those of other species by the antennular flagellum being concave in the basal part, while beyond the concavity it is flattened. This flattened part does not extend beyond the exopodite.

The following are the measurements of the three anterior legs :

	Merus.	Carpus.	Chela.
1st leg . . .	14 mm.	12 mm.	16 mm.
2nd leg . . .	15 mm.	16 mm.	17 mm.
3rd leg . . .	15 mm.	20 mm.	18 mm.

These relative measurements of the legs were found to be in harmony with those of the " Challenger " material.

From the above it is seen that the chela is longer than the corresponding merus and is longer in proportion to the carpus than in *A. semidentatus* Spence Bate, as is seen by comparing the figures given for the latter (*vide infra* under *A. alcocki*, p. 41). The dactylus, propodus and carpus of the last two legs and the carpus of the first three legs are ornamented with a longitudinal series of small pits, defined with red pigment.

The following are the measurements of the last two legs :

	Merus.	Carpus.	Propodus.	Dactylus.
4th leg. .	20 mm.	20 mm.	13 mm.	10 mm.
5th leg .	22 mm.	23 mm.	14 mm.	..

In the males of this species the scaphocerite is much thickened at the tip and the inner edge of the merus of the 1st leg is straight and not concave.

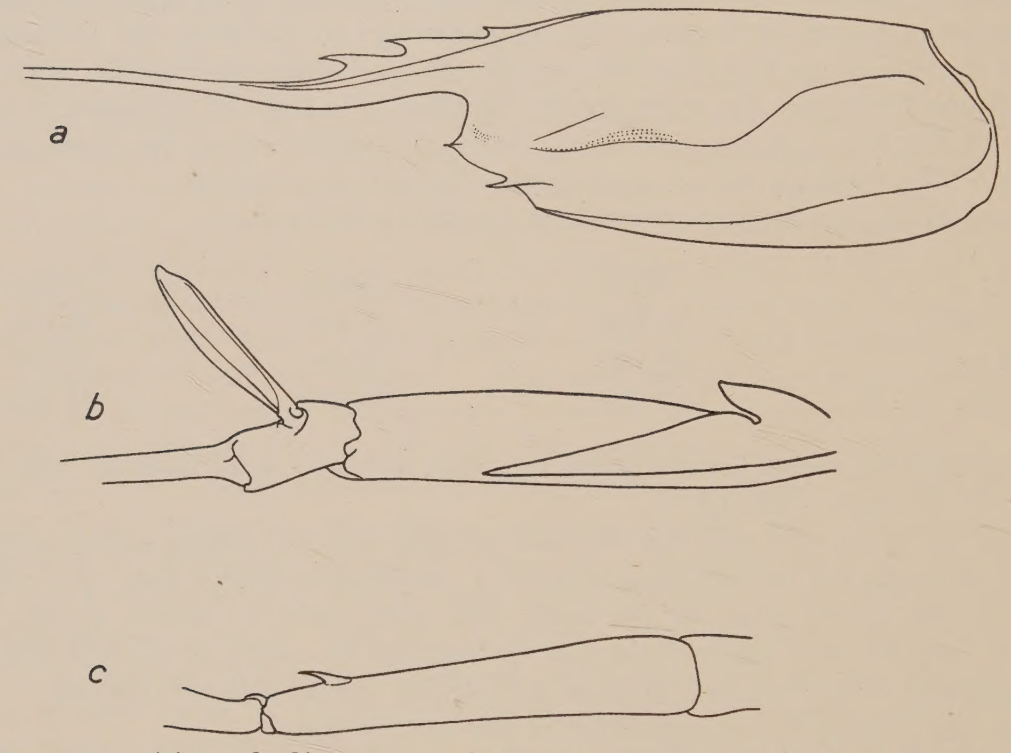
Some of the specimens of the German Deep-Sea Expedition, identified by Balss as " *A. semidentatus* ", have been examined by me. In certain of these (two males from " Valdivia ", Sta. 192, and 1 male and 1 female from Sta. 199) the body is pubescent and the three anterior legs possess a spine on their meri. The scaphocerite and the inner antennular flagellum are as described above, and the measurements of the legs are in harmony with the measurements given above. These specimens, therefore, belong to *A. virilis*.

Distribution.—This species is limited to the Indo-Pacific region ; Philippine Islands, New Hebrides, Andaman Sea and Zanzibar area (238–741 m.).

Aristeus alcocki sp. nov. (Text-figs. 1 *a–c* ; 2 *a* and 3 *a*.)

Aristeus semidentatus, Alcock, 1901, p. 31; Illus. Invest. Crust., pt. ix, 1901, pl. 49, fig. 3 ; Kemp & Sewell, 1912, p. 19. Nec *A. semidentatus* Spence Bate and Balss.

Occurrence.—(1) Sta. 34, Gulf of Aden, depth 1022 m. ; 4 females, 1 male.
(2) Sta. 35, Gulf of Aden, depth 450–550 m. ; 10 females, 8 males.
(3) Sta. 176, Gulf of Aden, depth 650–730 m. ; 2 females.
(4) Sta. 177, Gulf of Aden, depth 270–360 m. ; 3 females.
(5) Sta. 193, Gulf of Aden, depth 1051 m. ; 1 female.



Text-fig. 1.—*Aristeus alcocki* sp. nov. *a*, ♀, carapace. × 1·7. *b*, ♂, basal part of antennular flagellum. × 6. *c*, ♂, merus of 1st walking leg. × 6.

De Man (1911, p. 29), under *A. semidentatus*, writes : " It is with some doubt that these specimens are referred to *A. semidentatus*, because according to Alcock the pleurobranchiæ in advance of segment XIV should be mere little papillæ only visible with a lens." Kemp and Sewell (1912, p. 17), under " *A. semidentatus* ", remark : " It would appear doubtful whether the specimens obtained by the ' Siboga ' really belong to this species."

On examining the material of the " Challenger " (including the type), the two specimens from the " Siboga " collection, four specimens from the Indian Museum of the material referred by Alcock, Kemp and Sewell to " *A. semidentatus* ", and the material of the John Murray Expedition, it was found that the specimens of the " Challenger " and of the " Siboga " are similar and differ from the rest. The difference is not only in

FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

the nature of the branchiæ, but in other respects also. For the material obtained by the " Investigator " and described by Alcock, Kemp and Sewell and the material collected by this Expedition a new species has been established and is named after Alcock. This species is separated from *A. semidentatus* by the nature of the branchiæ, the position of the anterior part of the branchio-hepatic groove and the relative length measurements of the legs. In the specimens from the " Challenger " and those from the " Siboga " the pleurobranchiæ on segments X–XIII are not mere papillæ, but are distinct filaments, provided with pinnules, and in some of the " Challenger " specimens these filaments are quite big, while in *A. alcocki* these branchiæ are very minute papillæ, seen only with a lens and possessing no pinnules at all. In *A. semidentatus* (see Spence Bate, 1888, pl. 49, fig. 1) the buttress of the pterygostomian spine is long and the anterior part of the branchio-hepatic groove is straight and lies close to the buttress of the pterygostomian spine. In *A. alcocki* the buttress of the pterygostomian spine is very short but well developed, the branchio-hepatic groove is at a higher level than in *A. semidentatus*, so that there is a wide gap between it and the buttress of the pterygostomian spine, and its anterior part is not straight (Text-fig. 1 *a* ; Illustr. " Investigator ", pl. 49, fig. 3).

In *A. semidentatus* the chelæ of the three legs are distinctly shorter in proportion to the carpus than in this species. The following are the measurements of the legs of a female of the former species collected by the " Challenger " at Sta. 171 (carapace length 50 mm., not including rostrum).

	Merus.	Carpus.	Chela.
1st leg	18 mm.	14 mm.	15 mm.
2nd leg	19 mm.	19 mm.	16 mm.
3rd leg	20 mm.	25 mm.	18 mm.

	Merus.	Carpus.	Propodus.	Dactylus.
4th leg	24 mm.	26 mm.	16 mm.	7 mm.

The following are the measurements of a female specimen of *A. alcocki* (carapace length 35 mm., not including rostrum).

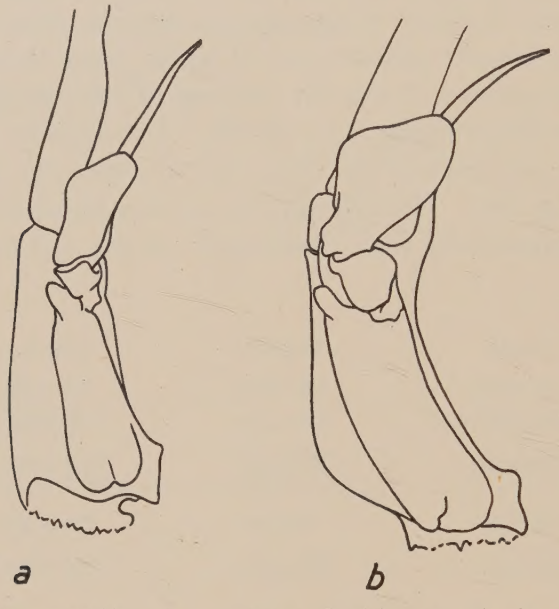
	Merus.	Carpus.	Chela.
1st leg	12 mm.	8 mm.	11 mm.
2nd leg	13 mm.	13 mm.	13 mm.
3rd leg	14 mm.	18 mm.	14 mm.

	Merus.	Carpus.	Propodus.	Dactylus.
4th leg	17 mm.	18 mm.	13 mm.	7 mm.
5th leg	16 mm.	18 mm.	14 mm.	7 mm.

From the above measurements it is clear that the chela in *A. alcocki* is longer in proportion to the carpus than in *A. semidentatus*.

The integument is glabrous and polished. The rostrum in the female is longer than the carapace and strongly recurved, and in the male it reaches the end of the antennular peduncle. The post-rostral carina extends beyond the gastric region to just in front of the denticle which exists at the posterior edge of the carapace ; but beyond the gastric

region the carina is very faint. The 3rd abdominal segment in two of the females from Sta. 34 ends in a spine. The telson is much smaller than the inner uropod and carries three movable spinules. The 3rd pair of legs just reaches the end of the scaphocerite; the 4th and 5th legs reach a little beyond the end of the scaphocerite. The meri are ornamented with red pits in the same manner as in *A. virilis*. The scaphocerite is very slightly thickened in the male, but not to the same extent as in *A. virilis*. In the male the inner antennular flagellum is very slightly twisted beyond the end of the exopodite and is notched but not flattened (Text-fig. 1 *b*). I am unable to find any difference between the males of this species and *A. semidentatus* in this respect, as the single male in the "Challenger" Collection is very young and the male specimen from the "Siboga" collection has the flagellum broken. The male of this species, however, is distinguished



TEXT-FIG. 2.—Appendix masculina of *a*, *Aristeus alcocki* n. sp. *b*, *A. mabahissæ* n. sp. × 6.

from that of *A. semidentatus* by having the inner edge of the merus of the 1st leg straight, while in the latter species it is concave ("Siboga" specimen). The two ultimate segments of the 3rd maxillipeds differ in the two sexes; in the female the propodus is of the same shape as the carpus, and gradually tapers distally, and the dactylus just exceeds half the length of the propodus; in the male the propodus is of a different shape and extends on the outer side beyond the insertion of the dactylus; it is flattened both on its outer side anteriorly and on its ventral side posteriorly, and the dactylus is three-quarters as large as the propodus. The appendix masculina and petasma are shown in Text-figs. 2 *a* and 3 *a*. The width of the petasma is more than half the length.

The average length of the females of the species is 140 mm., and of the males 110 mm., both measured from the tip of the rostrum to the end of the telson. This species is, on the whole, smaller in size than the other species of the genus, as females of the above length were sexually mature and were carrying spermatophores.

DISTRIBUTION.—Gulf of Aden, Arabian Sea (near Laccadives and Cape Comorin) and Bay of Bengal (270–1022 m.).

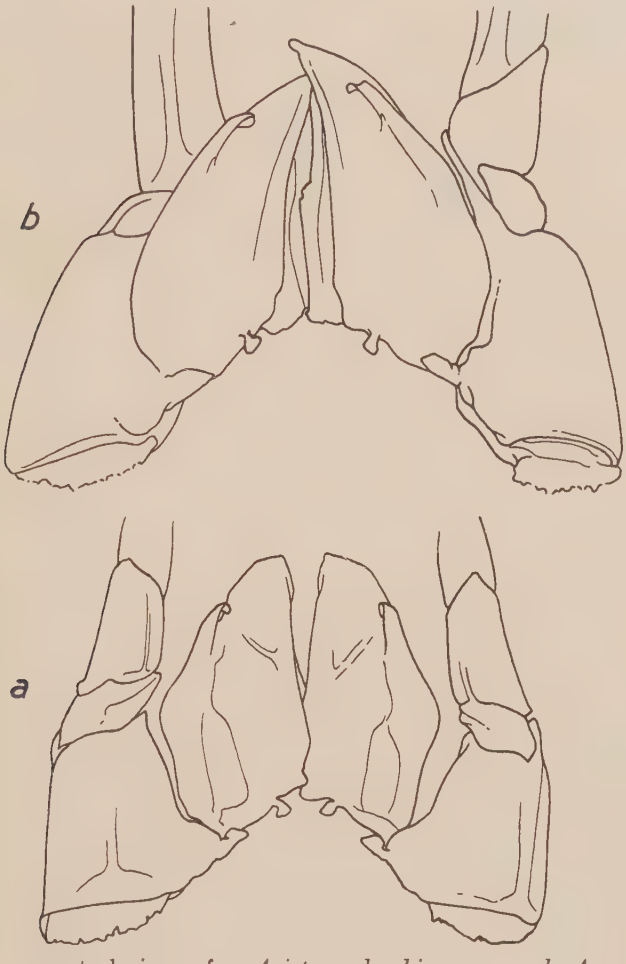
Aristeus mabahissæ sp. nov. (Text-figs. 2 *b*, 3 *b* and 4 *a–c*.)

Aristeus semidentatus, Balss, 1925, p. 224, in part.

Occurrence.—(1) Sta. 143, Maldive area, 795 m. ; 2 females.

(2) Sta. 145, Maldive area, 510 m. ; 2 females, 2 males.

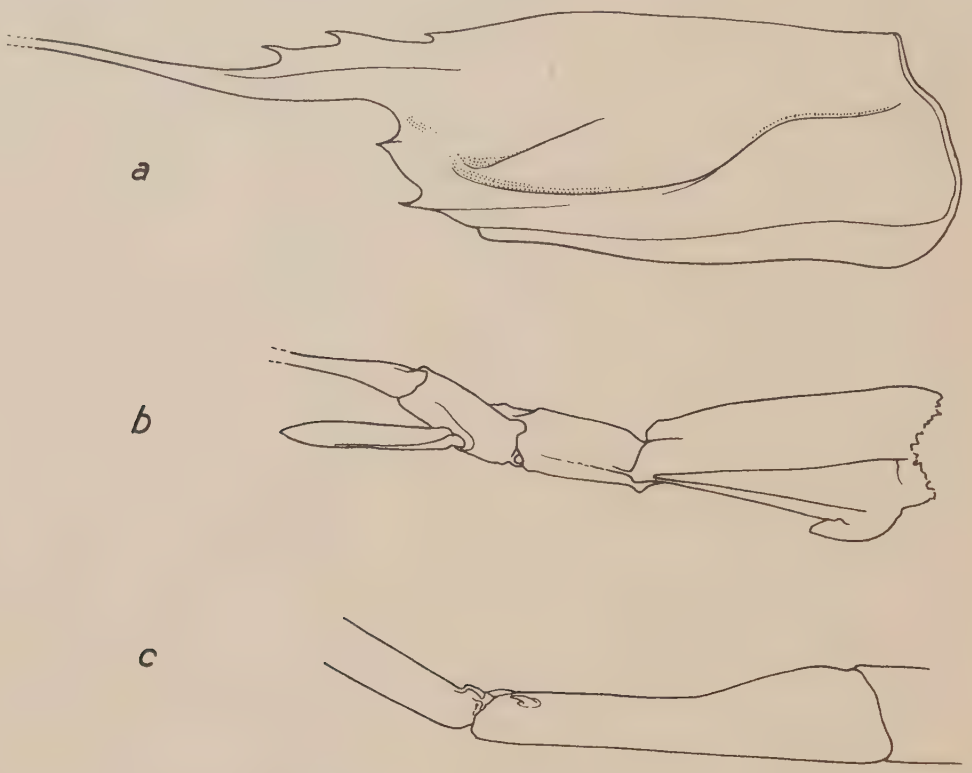
This species is closely related to *A. semidentatus* Spence Bate. In the nature of the pleurobranchiæ in advance of segment XIV and in the position of the anterior part of the



Text-fig. 3.—Petasma, ventral view, of *a*, *Aristeus alcocki* sp. nov. *b*, *A. mabahissæ* n. sp. × 5.

branchio-hepatic groove and in general shape of the body the two species do not differ. The integument is glabrous and polished. The rostrum is strongly recurved in the female and slightly so in the male ; in the three adult females the tip of the rostrum is broken, but the rostrum is at least as long as the carapace ; in the male it reaches beyond the antennular peduncle. The post-rostral carina is faint beyond the gastric region, and extends, as in *A. alcocki*, to just in front of the denticle at the posterior edge of the carapace (Text-fig. 4 *a*). In one male and one female the 3rd abdominal segment carries a spine medially on its posterior edge. The last three abdominal segments are sharply carinate and end in spines. The telson is shorter than the inner rami of the uropods and carries three movable spines. The merus of the 1st and 2nd legs carries a movable

spinule. In the female the 3rd legs reach the end of the scaphocerite, but are shorter in the male. The 2nd leg reaches beyond the spine of the scaphocerite, and the 1st leg reaches the end of the external maxillipeds. This species is easily distinguished from *A. semidentatus* by the measurements of the legs. The chelæ of the legs are longer in proportion to the carpus than in the latter species, but not as long as in *A. virilis* or *A. alcocki*; the last two legs differ in their measurements from any other species in the genus.



TEXT-FIG. 4.—*Aristeus mabahissæ* n. sp. *a*, ♀, carapace, × 1·3. *b*, ♂, basal part of antennular flagellum, × 3·3. *c*, ♂, merus of 1st walking leg, × 4·7.

The following are the measurements of the legs of a female (total length 180 mm.):

	Merus.	Carpus.	Chelæ.
1st leg	16 mm.	12·5 mm.	15 mm.
2nd leg	17 mm.	18 mm.	17 mm.
3rd leg	18 mm.	24 mm.	17 mm.

	Merus.	Carpus.	Propodus.	Dactylus.
4th leg	24 mm.	21 mm.	13 mm.	8 mm.
5th leg	24 mm.	24 mm.	14 mm.	9 mm.

On comparing the measurements given above with those given for *A. semidentatus* and *A. alcocki* the difference is clearly seen. The same relative lengths are found in the male. In the male the inner antennular flagellum is very much twisted beyond the exopodite and the twisted part is very flattened (Text-fig. 4 *b*). The general shape of the flagellum recalls that of *A. virilis*, but in the latter species the basal part is concave on the inner side and the twisted flattened part does not extend beyond the end of the

exopodite, while in this species it starts beyond the end of the exopodite (Text-fig. 4 *b*). The scaphocerite of the male is slightly thickened at the tip and the merus of the 1st leg is deeply concave on the inner side (Text-fig. 4 *c*). The propodus of the external maxilliped is not modified, as it is in *A. alcocki*. The appendix masculina and petasma are as shown in Text-figs. 2 *b* and 3 *b*, and their differences from *A. alcocki* will be best seen by comparing the figures ; in the petasma the length is about twice the breadth, while in *A. alcocki* it is decidedly less than twice the breadth. The legs are ornamented in the same way, but not as much, as in the other species. On the whole, the females of this species are separated from other species by the relative measurements of the legs, and the males by the shape of the antennular flagellum and the concavity on the inner edge of the 1st leg.

To this species belongs a female of the German Deep-Sea Expedition, identified by Balss as "*A. semidentatus*", taken at "Valdivia" Sta. 192. The measurements of the legs were found to be in harmony with the figures given above and the specimen was taken near the Maldives, as were the specimens obtained by the John Murray Expedition. The two females from Sta. 145 and one from Sta. 143 are adults, as they carry spermatophores and measure about 180 mm. ; the two males measure about 130 mm. One of the two females from Sta. 143 is very small.

Aristeus antennatus Risso.

Aristeus antennatus, Bouvier, 1908, pp. 71–75, pl. iii, figs. 2, 3 ; pl. xi, figs. 7–14 ; pl. xii.

Occurrence.—(1) Sta. 109, Zanzibar area, depth 640 m. ; 1 female.

(2) Sta. 115, Zanzibar area, depth 640–658 m. ; 2 females.

(3) Sta. 122, Zanzibar area, depth 732 m. ; 1 female.

(4) Sta. 143, Maldive area, depth 770 m. ; 1 female.

Bouvier's description of this species is very vague. He concentrated on comparing this species with *Plesiopenæus edwardsianus*. Such comparison between two species of different genera will naturally reveal many differences, but their value in defining the exact position of the species among its congeners is useless. His description can be applied to almost any other species of the genus. In his discussion of the affinities of the species, Bouvier mentions that the presence of the post-rostral carina beyond the gastric region, the presence of a small spine on the posterior edge of the 3rd abdominal segment and the sexual dimorphism exhibited by the 3rd maxillipeds are characters which distinguish this species from the others. In the light of our present knowledge of the other species of the genus, these characters are of no practical value in diagnosing *A. antennatus*. The post-rostral carina extends beyond the gastric region in all the other species examined by me, though only faintly in *A. antennatus*. The presence or absence of a denticle at the posterior edge of the 3rd abdominal segment cannot be considered a specific character, as this feature is subject to intra-specific variation ; such denticles or spines are present in some specimens of *A. alcocki* and *A. mabahissæ*. Sexual differences in the last two segments of the 3rd maxillipeds occur in other species of the genus, and in *A. alcocki* they are as developed as described by Bouvier for *A. antennatus*.

Before I saw any specimens from Bouvier's material I had already established a new species for the material of this expedition on the grounds of geographical distribution and on the relative lengths of the leg segments. I have since been able to examine the female specimen collected by the late Prince Albert of Monaco at Sta. 1114 (depth 851 m.),

the measurements of which are given by Bouvier (1908, p. 74) and which is figured on pl. iii and pl. xi. Bouvier (1908, p. 72) writes that the chela of the 3rd leg is equal to the carpus—a statement which neither agrees with his figure nor with the measurements of the 3rd leg of the actual specimen. I give below a description of this species. Bouvier's specimen, which is the largest collected by the Prince of Monaco, is 175 mm. long. The largest specimen taken by the John Murray Expedition is 190 mm. long (Sta. 115) and the smallest is 150 mm. (Sta. 109).

The body is glabrous and the branchio-hepatic groove is very clear, contrary to Bouvier's figure. In the smallest specimen taken by the John Murray Expedition it is not so marked as in the large specimens. The anterior part of the branchio-hepatic groove is at the same level as the pterygostomian spine, as in *A. semidentatus* and *A. mabahissæ*. The post-rostral carina extends beyond the gastric region to just in front of the posterior end of the carapace, but it is faint beyond the gastric region. The pleurobranchiæ in advance of segment XIV, though not as big as that on the XIVth, are plumose. The merus of both the 1st and 2nd legs carries a movable spinule anteriorly. The 3rd abdominal segment in Bouvier's specimen, as in all the other specimens, carries a small spine posteriorly, and the last three segments are carinate and end in spines. In Bouvier's specimen the 1st leg reaches the end of the 2nd segment of the antennular peduncle, the 2nd leg reaches the end of the antennular peduncle, the 3rd leg does not quite reach the end of the scaphocerite, the 4th leg reaches beyond the scaphocerite by more than half the dactylus. This reach of the legs applies to the small specimen taken at Sta. 109, but in the large specimen taken at Sta. 115, the 2nd pair of legs reaches the end of the squame and the 3rd reaches beyond the squame by half the dactylus, the 4th by the whole dactylus, and the 5th pair by the dactylus and a part of the propodus.

The following are the measurements of the legs of Bouvier's specimen (total length 175 mm.):

	Merus.	Carpus.	Chela.		
1st leg	16 mm.	11·5 mm.	15 mm.		
2nd leg	16 mm.	16 mm.	18 mm.		
3rd leg	17·5 mm.	21 mm.	18 mm.		
	Merus.	**Carpus.**	**Propodus.**		**Dactylus.**
4th leg	21 mm.	14 mm.	14 mm.		..
5th leg	20 mm.	28 mm.	17 mm.		8·5 mm.

The following are the measurements of the legs of the large specimen taken at Sta. 115 (total length 190 mm.):

	Merus.	Carpus.	Chela.		
1st leg	19 mm.	13 mm.	18·5 mm.		
2nd leg	19·5 mm.	19 mm.	21·5 mm.		
3rd leg	21 mm.	26 mm.	21·5 mm.		
	Merus.	**Carpus.**	**Propodus.**		**Dactylus.**
4th leg	26 mm.	27·5 mm.	15 mm.		12 mm.
5th leg	24 mm.	31 mm.	..		..

It will be seen that the measurements of the legs of these two specimens are proportionally in close agreement, and that in this species the chela of each of the anterior

three legs are much longer in proportion to the carpus than in *A. semidentatus* and *A. mabahissæ*, and that the carpi of the 4th and 5th legs are enormously longer in proportion to the meri than in *A. mabahissæ*. The exceptional length of the carpus of the 5th pair would easily differentiate this species from the others.

The ornamentation of the legs in this species is different from the others. In the large specimen from Sta. 115 and in the specimen from Sta. 122, the pittting of the legs is so close that it gives the impression of a continuous red line. In the other smaller specimens the pitting is not so close and in the Monaco specimen the pigment has disappeared.

To this species belong two female specimens of the German Deep-Sea Expedition, taken at " Valdivia " Sta. 251 and Sta. 254, which were identified by Balss as *A. semi dentatus*. These specimens were taken at almost the same locality as those of the John Murray Expedition, namely, on the East African coast. In both specimens the 3rd abdominal segment carries a spine medially on the posterior edges. Both specimens are 160 mm. long, and the following are the measurements of the legs of the specimen from Sta. 254 (carapace 78 mm. including rostrum) :

	Merus.	Carpus.	Chela.
1st leg	15 mm.	11·5 mm.	15 mm.
2nd leg	16 mm.	16 mm.	18 mm.
3rd leg	17 mm.	21 mm.	18 mm.

	Merus.	Carpus.	Propodus.	Dactylus.
4th leg	21 mm.	23 mm.	13·5 mm.	9 mm.
5th leg	19 mm.	26 mm.	16 mm.	9·5 mm.

These figures are proportionally in agreement with those given above. It will be noticed that the carpus of the 5th leg in this small specimen is actually longer than the corresponding joint in the large specimen of *A. mabahissæ* (180 mm. long).

I have not seen any male specimens of this species.

Distribution.—Mediterranean, East Atlantic Ocean and Indo-Pacific Ocean (Zanzibar area) (200–1400 m.).

Genus *Hemipenæus* Spence Bate.

Alcock, 1901, p. 31 ; De Man, 1911, p. 23 ; Balss, 1925, p. 223 ; Burkenroad, 1936, p. 90.

According to Alcock and Bouvier, *Aristeus* is distinguished from *Hemipenæus* by the reduction of the pleurobranchiæ in advance of the last thoracic segment and the absence of the cervical groove. As was shown under *Aristeus* (*vide supra*, p. 37), the pleurobranchiæ referred to above are not, as a rule, reduced, as is stated by most authors. The cervical groove in all the examples of the species of *Hemipenæus* examined by me is conspicuous by contrast with the indistinct groove of *Aristeus*. Burkenroad (1936, p. 90) states that in the specimens of *Hemipenæus spinodorsalis* Spence Bate contained in the collection of the Museum of Comparative Zoology, Harvard, the cervical groove is extremely faint. I have found, however, that the groove is conspicuous in the examples of the species in the collection of the British Museum. The fact that the pleurobranchiæ in advance of the last thoracic segment are not reduced, as they were supposed to be,*

* Alcock had only specimens of *Aristeus alcocki* for examination, and in that species the pleurobranchiæ referred to are mere papillæ (*vide supra*, p. 37).

and that the cervical groove is extremely faint in some specimens of *H. spinodorsalis*. makes the separation of these genera less sharp than was implied by Alcock. Burkenroad examined Faxon's material of *H. triton* Faxon and *H. spinodorsalis*, contained in the collection of the Museum of Comparative Zoology, Harvard, and found a podobranch on the 12th somite and an epipodite on the 13th somite in both these two species. He also found small exopodites on the legs. I have been able to confirm Burkenroad's observation of the presence of these structures in specimens of *H. spinodorsalis* in the collection of the British Museum, in a specimen of *H. triton* from the Museum of Comparative Zoology, Harvard, and in another specimen of this latter species collected by the Murray Expedition. Spence Bate's statement (1888, p. 300) that a podobranch occurs on the 12th somite and an epipodite on the 13th somite in *Hemipenæus*, together with his own observations on the two above-mentioned species, led Burkenroad to consider these structures as distinguishing *Hemipenæus* from *Aristeus*. But Burkenroad did not examine any material of *H. crassipes* Wood-Mason, *H. sibogæ* De Man, *H. speciosus* Spence Bate, or *H. gracilis* Spence Bate. *H. crassipes* and *H. sibogæ* possess no podobranch on the 12th somite, no epipodite on the 13th somite and no exopodite on the legs. The same observations apply to the specimens of *H. gracilis* and *H. speciosus* in the British Museum ; but these specimens are not in very good condition, and the fact that these structures in question are minute, when they occur, makes me unable to deny absolutely the occurrence of these structures in these two species. It is, however, evident that the branchial formula as given by Burkenroad is not representative of the genus.

This genus at present contains six species : *H. carpenteri* Wood-Mason (= *H. triton* Faxon), *H. spinodorsalis* Spence Bate, *H. speciosus* Spence Bate, *H. gracilis* Spence Bate, *H. sibogæ* De Man and *H. crassipes* Wood-Mason. I have examined the types of the first five species ; the last is represented in the present collection by seven specimens. In all the species, except *H. carpenteri* and *H. spinodorsalis*, the merus of the 1st and 2nd legs is armed with a spinule, similar to that described in all the *Aristeus* species examined. These two species are also easily distinguished from the rest of the genus by a number of characters which may entitle them to a subgeneric recognition : (1) They possess a spine at the end of the carina of the 4th abdominal segment ; (2) the three anterior legs have a much longer carpus than the other species, and their meri are not flattened ; (3) they possess a podobranch on the 12th somite, an epipodite on the 13th and exopodites on all the legs. *H. carpenteri* is separated from *H. spinodorsalis* by its short rostrum. Of the other four species, *H. speciosus* stands apart by the possession of a post-rostral carina which extends to the posterior region of the carapace, while *H. sibogæ* is distinguished from the remaining two species by the legs being covered with microscopical spinules. De Man (1911, p. 26) writes : " *H. gracilis* Spence Bate may be identical with this species (*H. sibogæ*) or with *H. crassipes*." I would note that *H. gracilis* is easily distinguished from the two other species under consideration by the brown colour of the eyes, which are black in the other two species,* and again from *H. sibogæ* by the absence of the microscopical spinules on the legs and by the dense tomentum of the body. The body of *H. gracilis* is slightly tomentose as that of *H. crassipes*, from which it is easily distinguished by the colour of the eyes.

Distribution. —*Hemipenæus carpenteri* : American Pacific, American Atlantic and

* This difference may be due to fixation and preservation, and may not hold in living specimens.

Indo-Pacific regions (1650–3872 m.) *H. spinodorsalis* : American Pacific, South Atlantic and Indo-Pacific regions (1867–3749 m.). *H. speciosus* : Atlantic Ocean (East of Buenos Ayres, 4847 m.). The other three species are limited to the Indo-Pacific area ; *H. gracilis* (1280 m.), *H. crassipes* (500–1737 m.) and *H. sibogæ* (1000 m.).

Hemipenæus crassipes (Wood-Mason).

Hemipenæus crassipes, Alcock, 1901, p. 33 ; Illus. Invest. Crust., pt. ix, 1901, pl. 49, figs. 1, 2 ; De Man, 1911, p. 24 ; Kemp and Sewell, 1912, p. 17, pl. 1, figs. 8 and 9.

Occurrence.—(1) Sta. 33, Gulf of Aden, depth 1295 m. ; 1 female.

(2) Sta. 184, Gulf of Aden, depth 1270 m. ; 1 female.

(3) Sta. 193, Gulf of Aden, depth 1060 m. ; 6 females.

The specimens agree with the cited descriptions and figures except in the following : The meri of the 1st and 2nd legs carry a movable spinule. The eye-tubercles, contrary to Alcock's statement, are rather prominent, as described by De Man. From De Man's (1911) description the specimens differ in having the first pair of legs reaching beyond the antennular peduncle, the second pair reaching beyond the scaphocerite by half the length of the dactylus, and the third pair by the whole length of the finger. There are no podobranchiæ on the third pair of legs, no epipodites on the fourth pair and no exopodites on any of the legs.

Distribution.—Arabian Sea, Malabar Coast, Gulf of Manaar, Bay of Bengal, Andaman Sea, Flores Sea and Makassar Straits (500–1737 m.).

Hemipenæus carpenteri Wood-Mason.

Hemipenæus carpenteri, Wood-Mason, 1891, p. 189 ; Alcock, 1901, p. 32 ; Illus. Invest. Crust., pt. ix, 1901, pl. 49, fig. 4.
Hemipenæus triton, Faxon, 1893, p. 215, 1895, p. 202.
Hemipenæus carpenteri, Burkenroad, 1936, p. 91.

Occurrence.—Sta. 171, central part of the Arabian Sea, depth 3840–3872 m. ; 1 female.

This specimen, which is 175 mm. long, has been compared with one of the types of *H. triton* Faxon (" Albatross ", Sta. 3374, depth 1823 m.), and has been found to be identical with it, agreeing in every detail. In this specimen there is a podobranch on the 3rd leg and an epipodite on the 4th. All the legs are provided with minute exopodites. I have not seen the type of *H. carpenteri*, and I follow Burkenroad in synonymizing *H. triton* with *H. carpenteri*.

Distribution.—American Pacific region, American Atlantic region and Indo-Pacific area (Arabian Sea and Bay of Bengal) (1650–3872 m.).

Genus *Plesiopenæus* Spence Bate.

Plesiopenæus, Alcock, 1901 ; Bouvier, 1908 ; De Man, 1911 ; Burkenroad, 1936.
Aristeus (part), Spence Bate, 1888 ; Wood-Mason and Alcock, 1891 ; Faxon, 1895.
Aristeopsis, Wood-Mason and Alcock, 1891 ; Alcock, 1901 ; Bouvier, 1908 ; De Man, 1911.

Species of this genus are easily distinguished by the absence of a hepatic spine on the carapace, the possession of a well-developed podobranch on segment XII and a well-developed epipodite on segment XIII.

Burkenroad's statement that they possess exopodites on the walking legs is not quite correct, as *P. edwardisianus* (Johnson) does not possess any such structures.

The name *Plesiopenæus* was provisionally proposed by Spence Bate (1888, p. 881) for forms related to *Aristeus* with an epipodite on the 13th somite. *Aristeus armatus* Spence Bate and *Aristeomorpha foliacea* (Risso) are the species discussed by Spence Bate (1888), which possess a well-developed epipodite on the 13th somite. In 1891 the genus *Aristeopsis* was established by Wood-Mason and Alcock (p. 284) with *Penæus edwardisianus* Johnson as the genotype, and to this genus they also referred *Aristeus armatus* Spence Bate. In 1895 Faxon (p. 199) designated *Aristeus armatus* Spence Bate as the genotype of Spence Bate's genus *Plesiopenæus*. Six years later Alcock (1901) transferred *Penæus edwardisianus* Johnson to *Plesiopenæus* Spence Bate, leaving *Aristeus armatus* Spence Bate as the only species of *Aristeopsis* Wood-Mason & Alcock. The reason for Alcock's action is obscure. It is clear from the above, as has been explained by Burkenroad (1936), that Alcock's action is the reverse of that necessitated by the history of the two species ; *Aristeus armatus* Spence Bate should be referred to the genus *Plesiopenæus* and *Penæus edwardisianus* Johnson to *Aristeopsis*. But Burkenroad (1936, p. 95) has synonymized *Aristeopsis* with *Plesiopenæus* on the grounds of similarity of the species referred to the two genera by previous authors.

Burkenroad's action is quite justified, and it seems that *Plesiopenæus coruscans* (Wood-Mason) is more nearly related to *Aristeopsis armatus* (Spence Bate) than to *Plesiopenæus edwardisianus* (Johnson), as will be shown below. The distinctions between *Plesiopenæus* and *Aristeopsis* as given by Alcock are (1) that the exopodite of the 2nd maxillipede is much longer than the endopodite in the former genus, and much shorter and slender in the latter, and (2) that the pleurobranchiæ in advance of the 14th segment are reduced in *Plesiopenæus*, while they are of normal size in *Aristeopsis*. Bouvier (1908, p. 187), in his key, states that *Aristeopsis* possesses exopodites on the walking legs, while *Plesiopenæus* does not. This statement is not correct. Bouvier did not see any specimens of *P. coruscans*, in which species Burkenroad has found small exopodites. The presence of exopodites in this species must have been overlooked by Alcock owing to the reduced size of these structures, and he has also overlooked their presence in *P. edwardisianus*, where they occur as stated by Bouvier, Burkenroad, and confirmed by myself. It is true that the pleurobranchiæ in advance of segment XIV are reduced in comparison with those on segment XIV, as stated by Alcock, in *P. cruscans* and *P. edwardisianus*. Burkenroad states that in his specimen of *P. coruscans* the pleurobranch on segment XIII is 10·5 mm. long, as compared with one of 18 mm. on the 14th segment. In a specimen of *P. edwardisianus* (carapace length 60 mm.) the pleurobranch on segment XIII is 7 mm. and that on segment XIV is 14 mm. In a specimen of *Aristeopsis armatus* (carapace length 55 mm.) the pleurobranchs on segments XIII and XIV are of equal length—9 mm. These measurements are in agreement with Alcock's statement ; but a mere reduction in the size of the pleurobranch, which, although small, is yet richly plumose, cannot be considered to be a valid generic character, particularly when there are no other distinctions between the species discussed. In the genus *Aristeus* the pleurobranchiæ of *A. alcocki* in advance or segment XIV are the merest rudiments, being minute papillæ with no pinnæ at all. The other distinctive character by which Alcock separates *Plesiopenæus* and *Aristeopsis* is not clear cut, as may be implied by Alcock's statement. There seems to be a gradual change in this respect from *P. edwardisianus* through *P. coruscans* to *Aristeopsis armatus*.

The exopodite of the 2nd maxillipede of *P. edwardisianus* is twice as long as the endopodite Burkenroad, 1936, p. 95), and in *Aristeopsis armatus* it is considerably shorter. In some respects *P. coruscans* (Wood-Mason), as I have already mentioned, is more nearly related to *P. armatus* than to *P. edwardisianus*; the two former species both possess exopodites on the walking legs, mobile spines on the meri of some of the walking legs (in *P. coruscans* in the 1st leg only and in *P. armatus* in the first two), and in both the ocular peduncle is flattened and the ocular tubercle well developed. *P. edwardisianus* is distinguished from both *P. coruscans* and *P. armatus* in having the first five abdominal terga carinate (*P. coruscans* has the last three terga carinate and *P. edwardisianus* the last four terga), and in having the outer antennal flagellum in the male produced in the form of a fleshy flagellum. On the other hand, *P. edwardisianus* and *P. armatus* resemble each other in having the terminal joint of the mandibular palp triangular with the inner edge concave, and in having the postero-lateral angles of the last four abdominal pleura mucronate.

Distribution.—*P. coruscans*, American Atlantic and Indo-Pacific regions (1026–1650 m.); *P. edwardisianus*, American Atlantic, Eastern Atlantic and Indo-Pacific regions (550–1850 m.); *P. armatus*, north and south Atlantic Ocean (750–5400 m.). None of the species of this genus occurs in the Mediterranean or in the American Pacific area.

Plesiopenæus edwardisianus (Johnson).

Plesiopenæus edwardisianus, Alcock, 1901, p. 36; Bouvier, 1908, p. 64, pl. 2, figs. 13–17, pl. 14, figs. 1–8; Burkenroad, 1936, p. 96.
Aristæopsis edwardisiana, Alcock, 1892, Illust. Zool. Invest. Crust., pt. i, pl. 1, figs. 1 and 2.

Occurrence.—Sta. 124, Zanzibar area, depth 913 m.; 2 females, 1 male.

Plesiopenæus armatus (Spence Bate).

Aristeus armatus, Bate, 1888, p. 312, pls. 45, 46.
Aristeus tridens, Smith, 1884, p. 404, pl. ix, figs. 1–6.
Plesiopenæus armatus, Faxon, 1895, p. 199.
Aristæopsis armatus, Alcock, 1901, p. 41; Bouvier, 1905, p. 983; 1909, p. 197.
Aristeopsis armatus var. *tridens*, Bouvier, 1908, p. 62, pl. 11, fig. 6; 1909, p. 197, pl. 1, figs. 4–7, text-figs. 20–37.
Aristeopsis tridens, Sund, 1920, p. 31.
Plesiopenæus armatus, Burkenroad, 1936, p. 96.

Occurrence.—Sta. 118, Zanzibar area, depth 1789 m.; 1 female, 1 male.

The female specimen is 140 mm. long; the male is a little shorter. Bouvier (1909) gives a number of characters by which this species is separated from the var. *tridens*. Sund, on the basis of the characters given by Bouvier, gave the variety specific rank. Burkenroad, however, remarks that several of the characters utilized by Bouvier are of no value. I examined the type-specimens of this species in the "Challenger" collection, and one female specimen of *P. armatus* var. *tridens* from the American Atlantic region in the collection of the Museum of Comparative Zoology, Harvard. The result of this examination led to the conclusion that both forms belong to the same species. The characters utilized by Bouvier for separating the species from the variety are given and discussed on p. 52.

	P. armatus.	*P. armatus* var. *tridens.*
Rostrum . . .	Strongly curved, S-shaped, the teeth are equally sloping; the median one is smaller than the distal one.	Little raised, nearly straight, the first and third teeth are more sloping than the middle one, which is the longest.
Stylocerite . .	Reaches only the end of the 2nd segment of the antennular peduncle.	Surpasses the end of this segment.
Male scaphocerite	Thickened at the distal end.	Not thickened at the distal end.
Exopodite of 2nd maxillipede	Very reduced, much shorter than merus of endopodite.	Equals $\frac{2}{3}$ the length of the merus in the type var., reaches to the last $\frac{1}{4}$ in the specimen of the " Princess Alice ", and to the end in the specimens of the " Blake " and " Talisman ".
Telson . . .	Equals the endopodite of the uropods.	Much longer than the endopodite of the uropods.
Infero-posterior angle of the 6th abdominal segment	Only an obtuse tooth.	Occupied by a sharp tooth surmounted by an obtuse lobe.

Bouvier adds that there may be other differences in the shape of the epistome or the petasma. Burkenroad adds another difference overlooked by Bouvier, namely, that the exopodite of the 1st pleopod is given by Alcock and figured by Spence Bate as being not much longer than the first four abdominal terga, whereas according to Smith in a specimen of his this appendage is as long as the first five abdominal terga. Before discussing each of the characters given by Bouvier I would note that the discussion is not based on the text or figures of previous authors, but on the examination of the material of the " Challenger ", the two specimens of the Murray Expedition and one female specimen of the variety from the American Atlantic region.

Rostrum.—In most of the specimens it curves upwards to some extent and the teeth are sometimes equally sloping, but there is no constant relation between the sloping of the teeth and the curvature of the rostrum. In a female specimen from the " Challenger ", Sta. 276, Low Archipelago, the rostrum is straight and does not rise at all.

Stylocerite.—In all the specimens of the " Challenger ", except one, it does not surpass the end of the 2nd antennular segment; the same is the case in the example of the variety. In the same exceptional specimen of the " Challenger " from Sta. 276, referred to above, the stylocerite surpasses the end of the 2nd antennular segment and almost reaches the end of the 3rd.

Scaphocerite.—Of the three males collected by the " Challenger ", that from Sta. 184 (near Torres Straits) and that from Sta. 323 the scaphocerite does not show any thickening at all. In that from Sta. 333 it is slightly thickened. In the male collected by the Murray Expedition it is not thickened at all. Bouvier himself writes that the scaphocerite is slightly thickened in one of the " Blake " specimens, referred by him to the variety. It is thus very obvious that this character cannot be given much importance.

Exopodite of the 2nd maxillipede.—Contrary to Spence Bate's, Alcock's and Bouvier's descriptions, I found that the exopodite in the " Challenger " specimens is at least half as long as the meropodite. In three cases it extends beyond the end of the merus. At the same time in the variety, where it should be at least three-quarters the length of the merus, it just reaches beyond the middle of the segment.

Telson.—In none of the specimens examined does the telson reach the end of the endopodite of the uropod.

Infero-posterior angle of the 6th abdominal segment.—As noted by Burkenroad, Bate's figure is incorrect in not indicating a tooth in this position. The tooth is present in all the specimens examined.

Epistome.—The shape of this region is very variable, and the different shapes it exhibits may be due to shrinkage during fixation of the animals.

Exopodite of the 1st pleopod.—In most cases it is less in length than (only in two cases does it equal) the first five abdominal terga. It is very clear from the above that not a single character of Bouvier's holds good and that all the characters are variable. I would note that one of the specimens referred by Spence Bate to *A. armatus* possesses three characters which, according to Bouvier, are diagnostic of the variety. This female specimen was taken at " Challenger " Sta. 276, Low Archipelago (Pacific) ; it has the rostrum straight, the stylocerite surpassing the end of the 2nd antennular segment, and the exopodite of the 1st pleopod as long as the first five abdominal terga. But this specimen is still young (carapace length 20 mm.), and these characters may possibly change with age.

From the above considerations *P. armatus* and *P. armatus* var. *tridens* must be considered as synonyms.

Distribution.—North and South Atlantic and Indo-Pacific regions (750–5400 m.).

Genus *Aristeomorpha* Wood-Mason.

Alcock, 1909, p. 38 ; Calman, 1925, p. 7.

Together with *Hepomadus* this genus is separated from the rest of the genera of the Aristæinæ by the possession of a hepatic spine on the carapace. From *Hepomadus* it is distinguished by the possession of a well-developed podobranch on the 12th somite and a well-developed epipodite on the 13th somite. When these two structures are present in *Hepomadus* they are very reduced (see *Hepomadus*, p. 55). *Aristeomorpha* also lacks the movable spine that is present on the meri of the 1st and 2nd legs in *Hepomadus* and other genera. This genus comprises two species, *A. foliacea* (Risso) and *A. wood-masoni* Calman. They are separated by a number of characters given by Calman (1925, p. 8). *Aristeus japonicus* Yokoya (1933) is probably identical with *A. foliacea*.

Distribution.—*A. foliacea* occurs in the Mediterranean, East Atlantic Ocean, and ranges the Indo-Pacific Ocean from the East African coast to Japan. *A. wood-masoni* occurs in the Andaman Sea.

Aristeomorpha foliacea (Risso). (Text-fig. 5 *b*.)

Aristeomorpha foliacea, Bouvier, 1908, p. 53, pl. iii, fig. i ; pl. xii, figs. 1–5 ; Kemp and Sewell, 1912, p. 18, pl. i, fig. 5 ; Calman, 1925, p. 7.

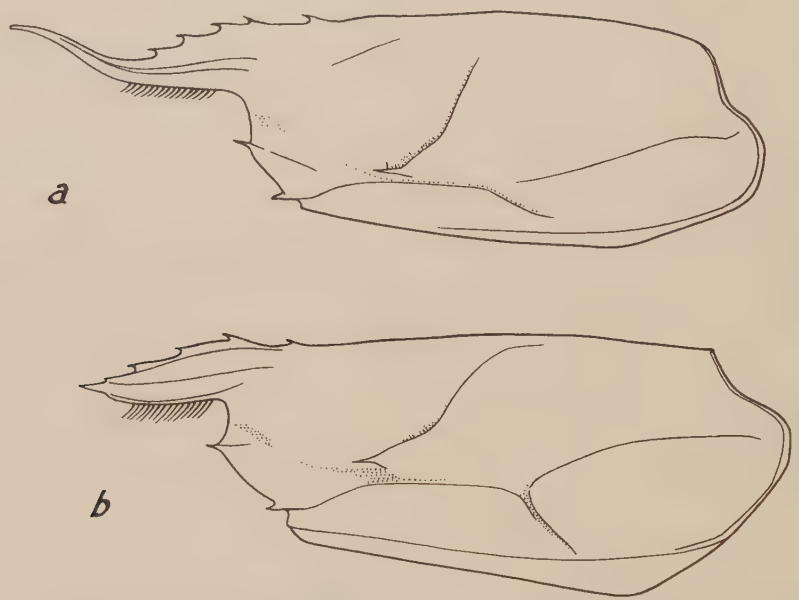
? *Aristeus japonicus*, Yokoya, 1933, p. 3.

[Nec *A. rostridentata*, Alcock, 1901, p. 39 ; Kemp and Sewell, 1912, p. 17, pl. i, fig. 6.]

Occurrence.—(1) Sta. 115, Zanzibar area, depth 640–658 m. ; 28 males, 23 females.

(2) Sta. 145, Maldive area, depth 494 m. ; 3 males, 1 female.

The specimens agree with the description given by Calman. The ratio of the length of the pterygostomian region to its breadth ranges from 3–4·5 ; the propodi of the 4th and 5th legs are more than twice as long as their respective dactyli, and the exopodites of the uropods reach well beyond the tip of the telson. Two young males from Sta. 115 (these measure 131 and 129 mm.) have the rostrum as long as in the female. The rostrum in one carries ten teeth and in the other eleven teeth. This may be due to the fact that the animals are still young. A similar case has been recorded by Calman in this species and by Bouvier (1908) in *Plesiopenæus edwardisianus*. To the sexual differences described by previous authors I would add that in the females the dactylus and propodus of the 4th pair of legs are as thick as those of the 5th pair, while in the male they are decidedly thicker.



Text-fig. 5.—*a*, *Aristeomorpha* sp. Carapace (tip of rostrum restored), × 1. *b*, *Aristeomorpha foliacea* (Risso). Carapace, × 1·7.

As I pointed out under *Aristeus* (*vide supra*, p. 37), *Aristeus japonicus* Yokoya should in all probability be referred to the genus *Aristeomorpha*, and as *Aristeomorpha foliacea* (Risso) is known to occur in Japanese waters, it is not improbable that *Aristeus japonicus* is a synonym of this species.

Distribution.—Mediterranean, East Atlantic and Indo-Pacific regions (400–1300 m.).

Aristeomorpha sp. (Text-fig. 5 *a*.)

Occurrence.—Sta. 115, Zanzibar area, depth 640–658 m. ; 1 female.

Unfortunately in this specimen the tip of the rostrum has been broken and the 4th and 5th legs are missing. In the areolation of the carapace it resembles *A. foliacea*. The following are the measurements in mm. :

Total length.	Rostrum.	Carapace.	Pterygostomian region :		
			Length.	Breadth.	Ratio.
175	27+	52	25	5·5	4·5 : 1

The only observed difference between this specimen and *A. foliacea* lies in the length, armature and peculiar shape of the rostrum. The rostrum in *A. foliaceus* is nearly twice as long as the carapace and reaches beyond the antennular peduncle by a few mm. In *A. foliacea* the rostrum carries seven teeth or more, while in this specimen it carries five teeth only. Again the rostrum shows a peculiar curvature. Diagrams of the carapace of both species are given for comparison in Text-fig. 5 *a*, *b*.

Genus *Hepomadus* Spence Bate.

Alcock, 1901, p. 42 ; Bouvier, 1908, p. 56 ; Burkenroad, 1936, p. 86.

According to both Alcock and Bouvier, the branchial formula of this genus differs from that of *Aristeomorpha* in the absence of a podobranch from the 12th somite and of an epipodite from the 13th somite. But Alcock (1901, p. 42) noticed the presence of a rudimentary epipodite on the 13th somite in a specimen from the Bay of Bengal. Burkenroad confirmed Alcock's observation, with the addition that the rudimentary epipodite is a subrectangular lamella rather than a tiny filament, as stated by Alcock. Burkenroad further observed that a vestigial podobranch is borne by the epipodite on the 12th somite in a juvenile female of *H. tener*, but not in the other available specimens. I am able to confirm Burkenroad's statement of the presence of a rudimentary subrectangular lamella on the 13th somite in a specimen of *H. tener*, and also in the type of *H. glacialis* ; but no podobranch could be seen on the 12th somite. In addition, the presence of small exopodites on the walking legs was noticed. There is also a movable spine on the merus of both the 1st and 2nd legs. This genus comprises three species—*H. tener* Smith, *H. glacialis* Spence Bate and *H. inermis* Spence Bate. The latter species is separated from the others by the absence of the spine on the posterior edge of the 3rd abdominal segment. *H. glacialis* is distinguished from *H. tener* by the possession of spines on the posterior edge of the 4th and 5th abdominal segments and by its characteristic carapace.

Distribution.—*H. inermis*, South Pacific Ocean ; *H. glacialis*, North-west Pacific Ocean, near Yokohama ; and *H. tener*, Atlantic Ocean (east coast of United States, Sargasso Sea) and Indo-Pacific region (Bay of Bengal and East African coast).

Bathymetric range.—Species of the genus are abyssal ; they have never been caught above 1540 m. : *H. inermis* (4665 m.), *H. glacialis* (3429 m.) and *H. tener* (1540–3150 m.).

Hepomadus tener Smith.

Hepomadus tener, Smith, 1884 and 1887 ; Bouvier, 1908 ; Burkenroad, 1936.
? *Hepomadus tener*, Alcock, 1901.

Occurrence.—Sta. 120, Zanzibar area, depth 2930 m. ; 1 female.

From Burkenroad's description of the specimens which he examined it seems that there is great variation in this species. The present specimen, which has been compared with the type of *H. glacialis* and was found to be completely different, exhibits considerable variation from the type in the relative length of the rostrum and the interval between the two anterior rostral teeth, and in the degree of development of the mid-dorsal carina of the carapace. The rostrum (19 mm.) is more than half the length of the carapace (35 mm.), and the interval between the two anterior rostral teeth (3·5 mm.) is one-third of the

distance between the last tooth and the tip of the rostrum (10·5 mm.), and about half the distance between the post-rostral and post-orbital teeth (8 mm.). The post-rostral carina is well developed and extends to just in front of the posterior edge of the carapace. The length of the tooth carried by the 3rd abdominal segment is $\frac{6}{11}$ of the distance between the transverse furrow and the posterior margin of the 3rd tergite. The differences between *H. tener* and *H. glacialis* as given by Bouvier (1909, p. 94) do not exist: Bouvier did not see the type of *H. glacialis*, and the specimen, which he (1909) refers to this species, does not belong to it. I have examined the type of the latter, and the following observations clearly indicate that Bouvier's species is different. The post-rostral carina extends to the post-cervical sulcus, then disappears over the cardiac region and appears again. The dorsal side of the carapace is raised and the convexity thus produced is characteristic, as is clearly shown in Spence Bate's figure. The length of the tooth at the posterior end of the 3rd abdominal tergite, as compared with the distance between the transverse furrow and the posterior margin of the 3rd tergite, is $\frac{6}{13}$. The 4th and 5th abdominal tergites are carinate and end in spines. The postero-inferior angle of the 6th abdominal segment is more pronounced than is indicated by Spence Bate's figure. The maxillary palp carries spines on both sides, six spines on its upper side in one row and nine on its lower side in two rows. It is thus evident that Milne-Edwards' and Bouvier's specimen, which they referred to *H. glacialis*, only resembles this latter species in the possession of teeth on the posterior edge of the 4th and 5th abdominal tergites. In the absence of spines from the upper side of the maxillary palp, in the relative shortness of the tooth of the 3rd abdominal segment, and in the dorsal side of the carapace forming a straight line when viewed in profile, Milne-Edwards' and Bouvier's (1909) male specimen differs from *H. glacialis*. If their description of this specimen is perfectly correct, it would seem probable that it represents a new species.

Distribution.—Indo-Pacific area (Bay of Bengal, 2304 m., Zanzibar area, 2930 m.), Atlantic Ocean (East coast of United States, 1541–3365 m., Sargasso Sea, 3150 m.).

Sub-family Solenocerinæ Wood-Mason.

Burkenroad, 1934*a*, p. 63, and 1936, p. 100.

According to Burkenroad this sub-family comprises three genera: *Solenocera*, *Haliporus* and *Hymenopenæus*. The former is characterized by the flattened antennular flagella being apposable so as to form a respiratory tube. *Haliporus* is separated from *Hymenopenæus* by the possession of podobranchs behind segment VIII. Species of the three genera have been discussed and reviewed by Burkenroad.

Genus *Solenocera* Lucas.

Solenocera hextii Wood-Mason.

Solenocera hextii, Alcock, 1901, p. 20; Illus. Invest. Crust., pt. iv, 1896, pl. 26, fig. 5.

Occurrence.—(1) Sta. 16, Gulf of Aden, depth 186 m.; 1 female.

(2) Sta. 48, South Arabian coast, depth 201–274 m.; 1 female.

The specimen from Sta. 16 is 110 mm. in length and the specimen from Sta. 48 is much smaller and damaged.

Distribution.—Bay of Bengal and Arabian Sea.

Solenocera rathbuni nom. nov. (Text-fig. 6.)

Solenocera lucassii, Rathbun, 1906, p. 904, pl. 20, fig. 9 ; Burkenroad, 1934*a*, p. 68.
[Nec *Solenocera lucassii*, Spence Bate, 1888, p. 277, pl. 42, fig. 4.]

Occurrence.—Sta. 106, Zanzibar area, depth 183–194 m. ; 1 female.

This specimen is 60 mm. long. The rostrum does not reach beyond the eyes. The post-rostral carina, contrary to Rathbun's description, extends beyond the gastric region to just in front of the denticle, which is present on the posterior edge of the carapace ; it is fairly distinct for a short distance behind the cervical groove and then becomes weak. The dorsal teeth are seven, of which three are on the carapace. There is no branchiostegal spine, although the carina leading to that part is well developed. From the point where a

Text-fig. 6.—*Solenocera rathbuni* nom. nov. Anterior part of carapace, × 5.

branchiostegal spine would be found a sharp ridge extends to the antennal spine. The antero-inferior angle of the carapace is produced forward in the form of a broad tooth, which cannot be described as a spine. The 3rd–6th abdominal segments are carinated, the carina of the 3rd not extending to the anterior edge of the segment, that of the 6th ending acutely. The telson is longer than the 6th abdominal segment and shorter than the uropods, and carries one pair of fixed spinules. The external maxillipeds reach beyond the antennular peduncle by the dactyl and a quarter of the length of the propodus. The 1st pair of legs is bispinose, carrying a spine on the base and one on the ischium, and reaches the anterior part of the carpus of the 3rd maxillipeds ; the dactyl is longer than the palm. The 2nd pair reaches the middle of the dactylus of the external maxilliped, the basis carrying a spine. The 3rd pair reaches by at least the palm beyond the external maxilliped, the carpus being somewhat expanded at the end.

Distribution.—Hawaiian Islands and Zanzibar area.

Genus *Hymenopenæus* Smith.

Hymenopenæus lucassi (Spence Bate).

Solenocera lucàsii, Spence Bate, 1881, p. 185.
Philoncus lucasii, Spence Bate, 1883, p. 277, pl. 42, fig. 4.
Haliporus lucasii, De Man, 1911, p. 43.
? Haliporus malhœnsis, Borradaile, 1910, p. 258, pl. 16, fig. 2.
[Nec *Solenocera lucasii*, Rathbun, 1906, p. 904, pl. 20, fig. 9.]

Occurrence.—Sta. 153, Maldive area, depth 256–293 m. ; 1 female.

This specimen is 70 mm. long and is completely identical with the type-specimen,

with which it has been compared. Borradaile's description of *Haliporus malhœnsis* is not sufficiently detailed to enable one to determine the identity of the two species, but his figure suggests that they are identical. Unfortunately the type of Borradaile's species no longer exists, so a comparison of both types could not be made.

Distribution.—Near Tanah Djampeah (120–400 m.), Halmaheira Sea (411 m.) (De Man); off the Kei Islands, South of Papua (Spence Bate); Saya de Malha (265 m.) (Borradaile).

Hymenopenœus propinquus (De Man).

Haliporus propinquus, De Man, 1911, p. 33, pl. 3, fig. 9.
Hymenopenœus propinquus, Burkenroad, 1936, p. 104.

Occurrence.—(1) Sta. 108, Zanzibar area, depth 786 m.; 1 male, 1 female.
(2) Sta. 109, Zanzibar area, depth 640 m.; 8 males, 2 females.
(3) Sta. 115, Zanzibar area, depth 640–658 m.; 3 females.
(4) Sta. 145, Maldive area, depth 510 m.; 36 males, 74 females.
(5) Sta. 193, Gulf of Aden, depth 1061–1080 m.; 4 males, 5 females.

The examples are not as large as those taken by the "Siboga". The largest range from 70–80 mm. long. The specimens taken at Sta. 115, Sta. 109 and Sta. 193 differ in some respects from those taken at Sta. 145; those taken at Sta. 108 are rather damaged. The specimens from Sta. 109, 115 and 193 all have the rostrum obliquely ascending and straight on both edges, as described by De Man, while those from Sta. 145 have the rostrum decidedly convex (in few cases very slightly). Again the 1st and 2nd legs in the specimens from the Zanzibar area agree with De Man's description, while in those from the Gulf of Aden they fail to reach as far as is stated by De Man. However, in the 3rd maxilliped and in the petasma the reverse is the case. The specimens from Sta. 145 in the Maldive area agree with De Man's descriptions, the 3rd maxilliped reaching beyond the scaphocerite by the dactylus only, while in those from the Zanzibar area the 3rd maxilliped reaches beyond the scaphocerite by the dactylus and from $\frac{1}{4}$–$\frac{1}{2}$ the propodus. Again the petasma of the male specimens from the Gulf of Aden agrees with De Man's description in having the anterior lobule much longer than the posterior one, while in the Zanzibar specimens the posterior lobule is very slightly shorter than the anterior one.

From De Man's description all the specimens differ in that the carina on the 1st abdominal segment is invariably absent.

Distribution.—Ceram Sea (835 m.), Bali Sea (538 m.), De Man.

Hymenopenœus sewelli sp. nov. (Text-fig. 7 *a–e*.)

Occurrence.—Sta. 156, Maldive area, depth 1828 m.; 1 female.

This female specimen is 65 mm. long. The integument is sub-membranous and leathery. The rostrum is obliquely ascending, but not straight, and carries 6 teeth. It extends beyond the middle of the 2nd segment of the antennular peduncle. The post-rostral carina is well developed and extends not quite to the posterior end of the carapace, the part anterior to the cervical groove is better developed than the part posterior to it, and is as high as the rostrum and carries two teeth. The carapace carries laterally five teeth, an antennal spine, a pterygostomian spine at the anterior edge of the carapace, a post-orbital spine at a lower level than the antennal, a branchiostegal spine behind and at the

same level as the pterygostomian, and a hepatic spine at the anterior end of the cervical groove. All the spines, except the antennal one, are prolonged backwards in the form of a carina. The posterior carina of the branchiostegal spine is long, and behind it two carinæ run backwards along the branchial region ; the upper one ends at the posterior

TEXT-FIG. 7.—*Hymenopenæus sewelli* n. sp. *a*, Posterior part of abdomen, × 4. *b*, ♀ carapace, × 4. *c*, Epipodite on 1st leg. *d*, Epipodite on 4th leg. *e*, Thelycum, × 11.

margin of the carapace, and the lower one runs downwards and backwards to join the submarginal carina of the carapace.

The 4th to 6th abdominal segments are sharply carinated, the carinæ being very high and ending in acute teeth (Text-fig. 7 *a*). The 5th segment carries a longitudinal carina laterally and the 4th segment is grooved posteriorly. The 6th abdominal segment is less than twice as long as the 5th. The telson is unfortunately broken, but sufficient remains to show that it must have been longer than the 6th segment.

The eyes are black and not much wider than the peduncle. They extend to the middle of the basal segment of the antennular peduncle. The basal segment of the antennular peduncle bears at its antero-external angle a well-developed spine. The 2nd segment is more than twice as long as the 3rd.

The 1st pair of legs reaches the middle of the carpus of the 3rd maxilliped. The fingers are almost $1\frac{1}{2}$ times as long as the palm. The 2nd pair of legs reach beyond the end of the carpus of the 3rd maxilliped, and the fingers are just longer than the palm. The 3rd pair of legs is missing. The dactyls and propodus of the 4th and 5th pairs are also missing, but the carpus of the 5th pair reaches the end of the antennular peduncle. Exopodites are present on all the legs, but are very small. Epipodites are present on all the legs except the last. The basal part of the epipodite is short and broad, not more slender than the terminal broad lamina, and the latter is not furcate but has one side more pronounced than the other ; the lamina is less broad on the posterior legs than on the anterior ones (Text-fig. 7 *c*, *d*).

Thelycum (Text-fig. 7 *e*)—The coxæ of the 3rd pair of legs are produced inward as large tubercles, on which the oviducts open, and are covered with stiff hair. Behind these on either side is an elongate tongue-like sternal structure. Between the 4th pair of legs is a structure which is divided into an anterior part, and a posterior part which is deeply notched posteriorly. The posterior part is more or less vertical. Between the 5th pair of legs is a more or less conical structure covered with hair.

The specimen appears to represent a new species of *Hymenopenæus* belonging to Section 1 of Group IV of Burkenroad. This section is characterized by the possession of a branchiostegal and pterygostomian spine on the carapace. This species is more related to *H. nereus* (Faxon) than to *H. doris* (Faxon) or *H. lævis* (Bate).

Before stating the differences between this species and *H. nereus* Faxon and related species, I would note that Faxon's description of the 3rd abdominal segment is not correct. Faxon (1895, p. 189) writes, " the 3rd to 6th abdominal segments are carinated ". Mr. Fenner A. Chase, jun., of the Museum of Comparative Zoology, Harvard, who had kindly examined four specimens of Faxon's material, informs me that " the 3rd abdominal segment is not carinated in any of the specimens ; the 4th and 5th abdominal segments show no trace of a posterior spine ; on the other hand, they are notched for the reception of the succeeding segments ; the structure on the sternum of the 5th legs is not triangular, but just as shown in Faxon's figure ". The present species differs from *H. nereus* by the following :

(1) The shape of the rostrum.

(2) The carina of the 4th and 5th abdominal segments, which in this species end in acute teeth, while in *H. nereus* and related species they are notched posteriorly.

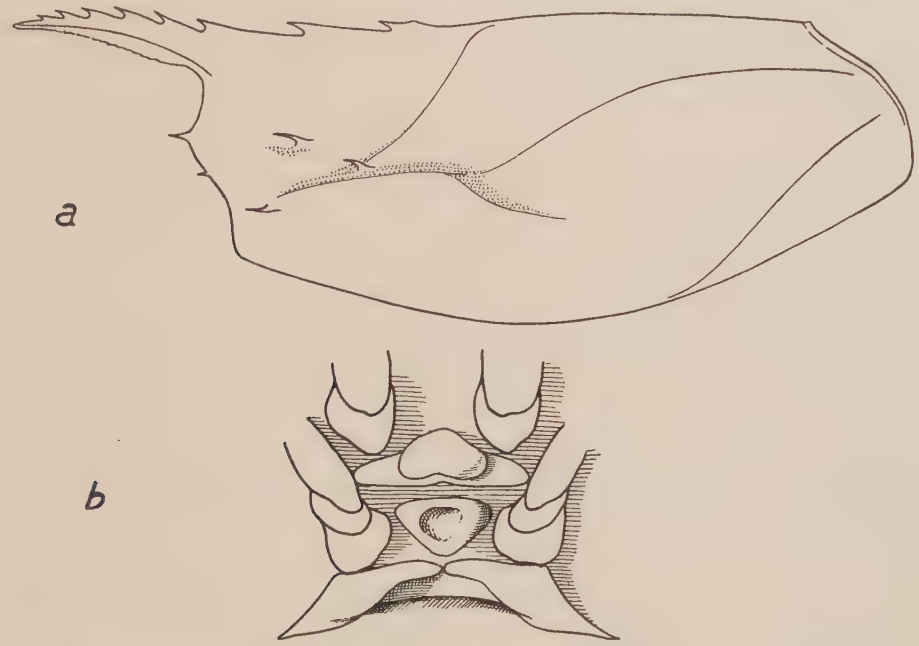
(3) The shape of the thelycum.

Hymenopenæus fattahi, sp. nov. (Text-fig. 8 *a*, *b*.)

Occurrence.—Sta. 54, South Arabian coast, depth 1046 m. ; 42 males, 19 females.

These examples represent a new species of *Hymenopenæus* belonging to Section 2 of Burkenroad's Group IV. This section is characterized by the possession of a branchiostegal spine, but not of a pterygostomian one, and by having the 4th and 5th pairs of legs very long, reaching far beyond those of the 3rd pair. The length of the

specimens varies from 40–50 mm. The integument is semi-membranous and glabrous. The rostrum is obliquely ascending in both sexes. In some specimens it is nearly straight, but in the majority it is slightly arched. The lower margin is fringed with long hairs. It reaches the end of the 1st antennular peduncle and carries six to seven teeth, besides the two epigastric ones. The post-rostral carina runs to the middle of the carapace, a few mm. beyond the level of the cervical groove. The carapace is armed with four spines, an antennal, a post-orbital, a hepatic and a branchiostegal spine behind and above the antero-inferior angle of the carapace. All the spines are comparatively small ; the antennal is very small and in some specimens is almost absent. The post-orbital spine is placed on the same level as the antennal one and the hepatic at a slightly lower level. The anterior edge of the carapace below the antennal spine does not round into the lower edge, as in other



TEXT-FIG. 8.—*Hymenopenæus fattahi* n. sp. *a*, Carapace, × 6. *b*, Thelycum.

species, but there is a distinct angle at the antero-inferior corner of the carapace, the anterior edge of the carapace being straight. On the branchiohepatic region there is a well-developed L-shaped groove with the posterior limb almost parallel to the dorsal edge of the carapace. The anterior part of the branchiostegal region is sharply defined, and bulges at a higher level than the rest of the carapace. The 1st–3rd abdominal segments are not carinated ; the 4th–6th segments are carinated, the 6th alone ending in a spine. The carina of the 4th and 5th segments are cut posteriorly for the reception of the succeeding segments.

The telson is longer than the 6th abdominal segment and carries a pair of small fixed spinules. It is broadly concave throughout the whole length. The eyes are wider than the peduncles and not completely black, having a brownish tinge. The antennular peduncle does not reach the end of the scaphocerite, the distance between the end of the peduncle and that of the scaphocerite being almost equal to the terminal segment. The antennal peduncle reaches beyond the end of the 1st segment of the antennular peduncle. The external maxillipeds reach beyond the scaphocerite by less than the dactylus. The

1st pair of legs reaches the end of the 1st antennular segment and carries no spines ; the setiferous organ is well developed ; the finger is $1\frac{1}{2}$ times as long as the palm, measured along the middle line, and the carpus is a little shorter than the merus. The 2nd pair of legs reaches beyond the end of the 2nd antennular segment ; the finger is $1\frac{1}{2}$ times as long as the palm and the carpus is longer than the merus. The dactylus and propodus of the 4th and 5th legs are missing in all the specimens, but the carpi reach almost to the end of the antennular peduncle. There are no exopodites on the legs, but epipodites are present on all the legs except the last. The epipodites (except that of the 4th leg) are well developed, the stalk is very long, the terminal lamina is well furcated. The epipodite on the 4th leg is a mere filament without furcate lamina. Each half of the petasma is divided into two unequal lobules, the anterior being longer and its obtuse tip nicked. The posterior lobe is more or less triangular. The edge of the anterior lobe is beset with stiff microscopic spinules. There is a round tooth on the sternum of the 1st abdominal segment in the male.

The thelycum is represented in Text-fig. 8 *b*. The two tubercles on which the oviducts open are longer than broad and are covered with hair : behind these is a pair of small sternal structures. Between the basis of the 4th legs there is a plate, rounded anteriorly with obtuse upper edge and bounded posteriorly by two processes from the bases of the 4th legs. This plate is covered with hair.

In spite of the great number of specimens obtained, there is not a single specimen which is in good condition : the softness of the tissues of the animals and the change of pressure (the animals having been taken at a depth of 1046 m.) may be responsible for this.

This species is easily distinguished from the others belonging to Group IV, Section 2 of Burkenroad by the semi-membranous integument and soft tissues and by the presence of the L-shaped groove on the branchial region.

Sub-family Penæinæ.

Genus *Penæus* Fabricius.

Penæus indicus Edwards.

Penæus indicus, Alcock, 1906, p. 62, pl. 1, figs. 3, 3*a*.

Occurrence.—Sta. 37, Gulf of Aden, depth 18–22 m. ; 1 male.

The specimen is 165 mm. long. The rostral formula is 8 : 4. The post-rostral carina extends backwards to about 5 mm. in front of the posterior edge of the carapace and carries a very fine groove which widens in two regions, one 4 mm. and the other 1·5 mm. in length. De Man (1911, p. 103) has found in the variety *longirostris* that the post-rostral carina, though not grooved, shows usually two or three shallow pits.

Distribution.—Indo-Pacific region.

Penæus marginatus Randall.

Penæus marginatus, Rathbun, 1906, p. 55, pl. 19, fig. 2.
? Penæus canaliculatus, De Man, 1888, p. 565.

Occurrence.—Station unknown ; 1 female.

The specimen is 180 mm. long. The post-ocular crest turns upon itself at the posterior end, and forms a loop as found in the Indo-Pacific species of Division 2 of

Burkenroad. The 1st leg is bispinose and the post-rostral carina is not grooved. The telson carries 3 pairs of spinules. In 1888 De Man (*loc. cit.*) described two female specimens which were identified by him as *P. canaliculatus*. In these the post-rostral carina is not grooved and the 1st legs are bispinose. In 1911, p. 107, under *P. canaliculatus*, he refers to these two females as individual varieties of the latter species, but it is quite probable that they actually belong to *P. marginatus*.

Distribution.—Indo-Pacific region.

Genus *Trachypenæus* Alcock.

Burkenroad, 1934*a*, p. 94, and *b*, p. 49.

Trachypenæus curvirostris (Stimpson).

Penæus anchoralis, Spence Bate, 1888, p. 258, pl. xxxv, fig. 1, part (only males).
Trachypenæus asper, Alcock, 1906, p. 43, pl. 9, figs. 28, 28*a* and *b*.
Trachypenæus anchoralis, De Man, 1911, p. 88, pl. 8, fig. 28.
Trachypenæus anchoralis, Schmitt, 1926, p. 353, pl. 63, figs. 2, 3.
For further synonymy see Schmitt.

Occurrence.—Sta. M.B. I, Red Sea, depth 26 m. ; 1 female.

The specimen is 55 mm. long. The rostrum is straight, and carries 10 teeth in addition to the epigastric one. The post-rostral carina is sharp and well-developed. The antero-inferior angle of the carapace is slightly dentiform. The thelycum exactly resembles the figure given by Schmidt. The longitudinal suture of the carapace in front of the hepatic spine is faint and is only seen when carefully looked for. There is no spine on the basis of the 3rd maxilliped and the ischium of the 1st leg carries no spine. There is an epipodite on the 1st and 2nd legs, as well as on the 3rd.

Among the characters used by Burkenroad, for separating members of Section 2 from Section 1, in Division I, is the presence of a spine on the ischium of the 1st leg. No great importance should be attached to this character, as the presence or absence of a spine is subject to variation, at least in this species. As mentioned above, there is no spine on the ischium in the present specimen. Alcock (in *T. asper*) and De Man (in *T. anchoralis*) mention the presence of a spine on the basis but not on the ischium. However, the spine on the ischium is present in two male specimens from the " Challenger " Collection, and is missing in the other two males.

Distribution.—Indo-Pacific region.

Genus *Funchalia* Johnson.

Burkenroad, 1936, p. 126.

Sub-genus *Funchalia*.

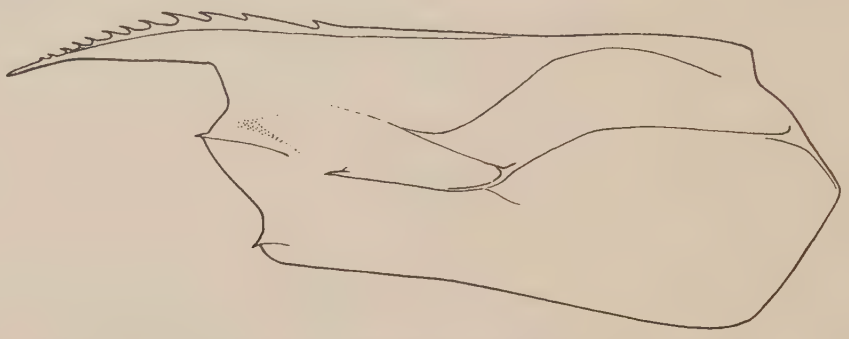
Funchalia (*Funchalia*) *woodwardi* Johnson (Text-fig. 9).

Funchalia woodwardi, Calman, 1925, p. 10, pl. 2, fig. 5, pl. 3, figs. 6–8.
Funchalia woodwardi, Burkenroad, 1936, p. 126.

Occurrence.—Sta. 96, Central part of Arabian Sea, depth 10 m. ; 1 male, 2 other very small specimens.

The largest specimen (male) is 50 mm. long ; the length of the carapace from the base of the orbit to the hind dorsal edge is 13 mm. The two very small specimens are

25–27 mm. long. The large specimen agrees with Calman's description and differs from Bouvier's in the following : (1) The mandible ; (2) the possession of only two branchiæ (pleurobranch and arthrobranch) besides the podobranch on the somite of the 2nd maxilliped ; (3) the possession of a row of spinules on the telson instead of three pairs. It differs, however, from Calman's figure in two respects : (i) In the holotype and in the specimen from South Africa (as shown by Calman's figure) the pterygostomian spine is placed at the antero-inferior angle of the carapace, while in this specimen it is placed at a higher level ; (ii) the rostrum in the holotype is broken, but in Calman's specimen from South Africa, which I have examined, it is broad at the base and its lower margin rounds into the anterior edge of the carapace, while in this specimen the junction of the lower



Text-fig. 9.—*Funchalia* (*Funchalia*) *woodwardi* Johnson. Carapace, × 6·7.

margin and the carapace is angular. These differences may be due to this specimen not having assumed fully adult characters. I would note here that Calman's figure omits—(1) a ridge on the carapace dorsal to the one carrying the hepatic spine and with which it is connected ; (2) a lateral groove on the 4th abdominal segment. Both structures were found to be present in the type-specimen and in the specimen from South Africa, both of which I was able to examine in the British Museum. The two small specimens seem to be a post-larval stage of *Funchalia*. In these the body is not pubescent, the eyes are not wider than the eye stalks, and the prosartema does not reach beyond the cornea of the eye.

Distribution.—Eastern North Atlantic and South-eastern Atlantic regions (Burkenroad) ; Indo-Pacific region (Balss).

Sub-genus *Pelagopenæus* Burkenroad.

Burkenroad, 1936, p. 77.

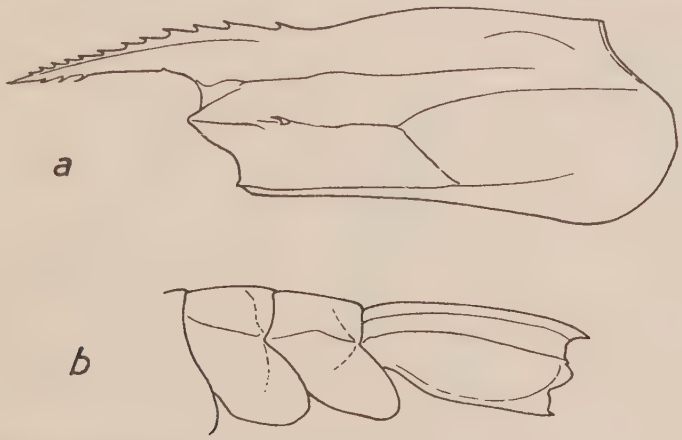
Funchalia (*Pelagopenæus*) *balboæ* (Faxon). (Text-figs. 10 *a*, *b* ; 11 *a–g*.)

Penæus balboæ, Faxon, 1895, p. 181 ; Schmitt, 1935, p. 20.
Penæus meridionalis, Lenz and Strunk, 1914, p. 298.
Funchalia (*Pelagopenæus*) *balboæ*, Burkenroad, 1934*a*, p. 76 ; 1936, p. 136.
Funchalia (*Pelagopenæus*) *meridionalis*, Burkenroad, 1934*a*, p. 77.

Occurrence. —Sta. 96, Central part of the Arabian Sea, depth 10 m. ; 2 specimens.

Integument soft but not membranous, and glabrous. The rostrum extends a little beyond the end of the 2nd segment of the antennular peduncle, and carries a carina on the lateral side. In the large specimen the rostral formula is 12 : 3 and in the small

specimen 13 : 3. Besides the three teeth on the ventral edge of the rostrum in the large specimen, there is a rudiment of another one. Of the dorsal teeth three lie on the carapace (Text-fig. 10 *a*). The rostrum is more than half the length of the carapace ; the latter measured 12 mm. along the lateral wall from the antennal spine to the posterior edge exactly along the central ridge which carries the hepatic spine ; the rostrum measured 9·5 mm. The post-rostral carina is as high as the rostrum, and extends to a few mm. in front of the posterior edge of the carapace. There is a pterygostomian spine at the anterior edge of the carapace. On the lateral side of the carapace there are four ridges, the most prominent of which carries the hepatic spine and extends along the carapace from the antennal spine to the posterior edge : this ridge is not continuous, but is interrupted just in front of the hepatic spine. The ridge below this extends backwards from the pterygostomian spine, but does not reach the posterior edge of the carapace. These two ridges are connected by a transverse ridge. The other two ridges are dorsal to that carrying the hepatic spine ; the ventral one is shorter than the one last mentioned and

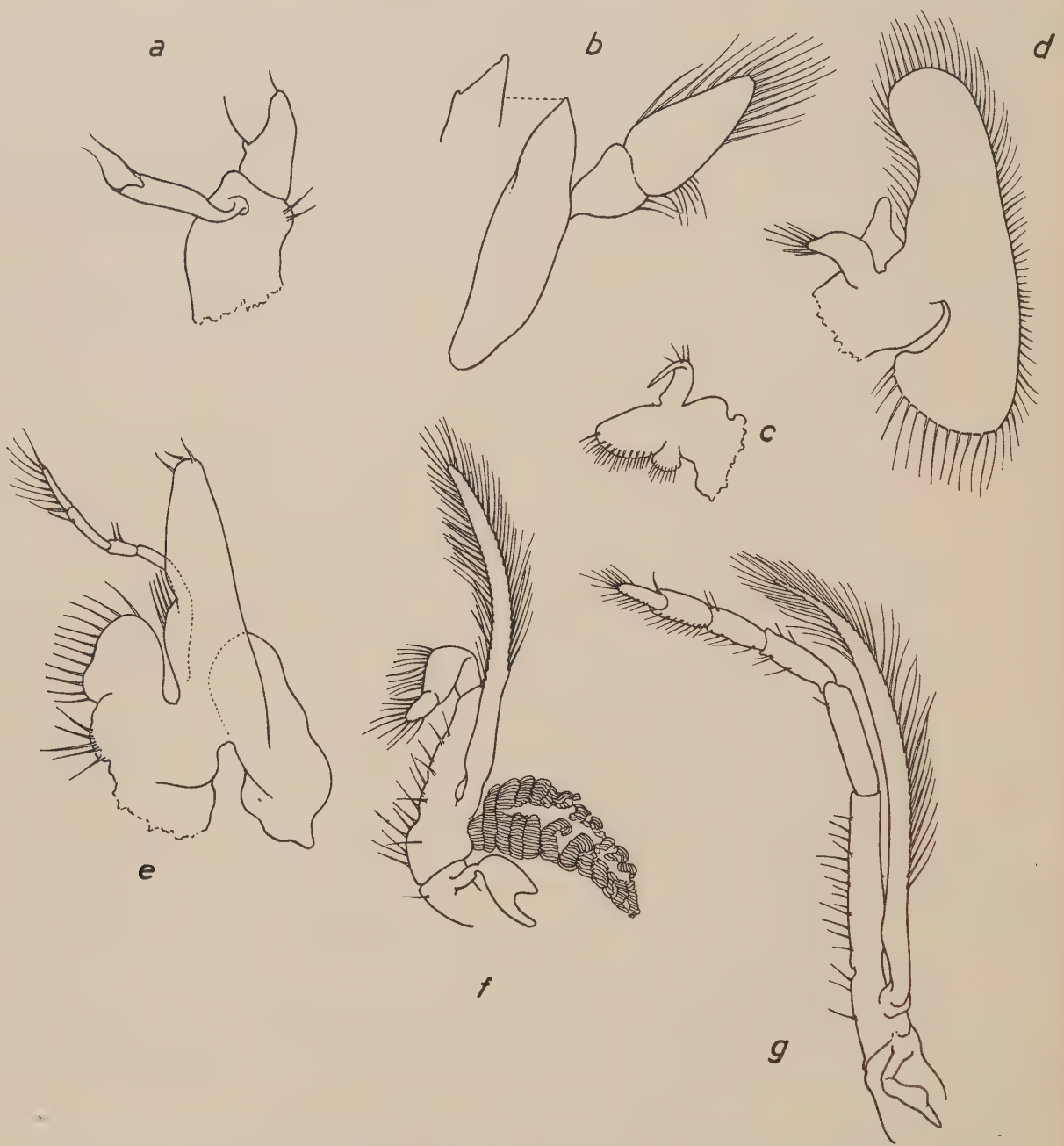


Text-fig. 10.—*Funchalia* (*Pelagopenæus*) *balboæ* (Faxon). *a*, Carapace, × 4·7. *b*, Three posterior abdominal segments, × 4·7.

does not reach either edge of the carapace. The dorsalmost ridge is short and is confined to the posterior part of the carapace but does not reach the posterior edge. The 4th–6th abdominal segments each carries a high carina, the last ending in a spine. The pleura of the 4th and 5th segments are prolonged backwards (Text-fig. 10 *b*). The 4th–6th abdominal segments each carries laterally a well-developed ridge, that on the 4th segment being oblique. The 6th abdominal segment is a little longer than the 4th and 5th together. The telson is symmetrical, slightly shorter than the 6th segment and very broadly grooved, with the upper edges of the grooves very sharp. I am unable to find more than three pairs of very minute spinules on the posterior end of the telson.

The eyes are sub-spherical and not quite black, having a brown tinge ; they are twice as wide as the stalk in the large specimen, while in the small specimen they are not much wider than the stalk : this is probably due to age. The prosartema is short and does not reach the end of the eyes. The outer wall of the basal segment of the antennular peduncle is raised. The 3rd segment is more than half as long as the 2nd. The antennular flagella are long, thickened at the base, the outer being shorter than the inner and the latter is less than twice as long as the antennular peduncle. The mandibular crown is prolonged inward, but is not long enough to be described as of a stylet form

(Text-fig. 11 *b*). The proximal endite of the 2nd maxilla is missing, as it is in the sub-genus *Funchalia*. The 3rd maxillipeds reach the base of the scaphocerite. The legs are short; the 2nd are a little shorter than the external maxillipeds; the 3rd reach almost the middle



Text-fig. 11.—*Funchalia* (*Pelagopenæus*) *balboæ* (Faxon). *a*, Epipodite on 3rd leg. *b*, Mandible. *c*, 1st maxilla. *d*, 2nd maxilla. *e–g*, Maxillipeds.

of the eye; the 4th legs are a little shorter than the 3rd, and the 5th are shorter than the 4th. I am unable to find any exopodites on any of the legs. The epipodites are missing from the 4th and 5th legs, and the broad lamina of the epipodites on the other legs are furcate in the usual way.

The edges of the fingers are sharp and the movable fingers carry two teeth. The setiferous organ is present on the 1st leg.

The smaller specimen does not show any trace of sexual organs, the larger one carries a small lamina on the inner edge of the 1st abdominal limb, and the sternum of both specimens of the 1st abdominal segment carries a well-developed tubercle.

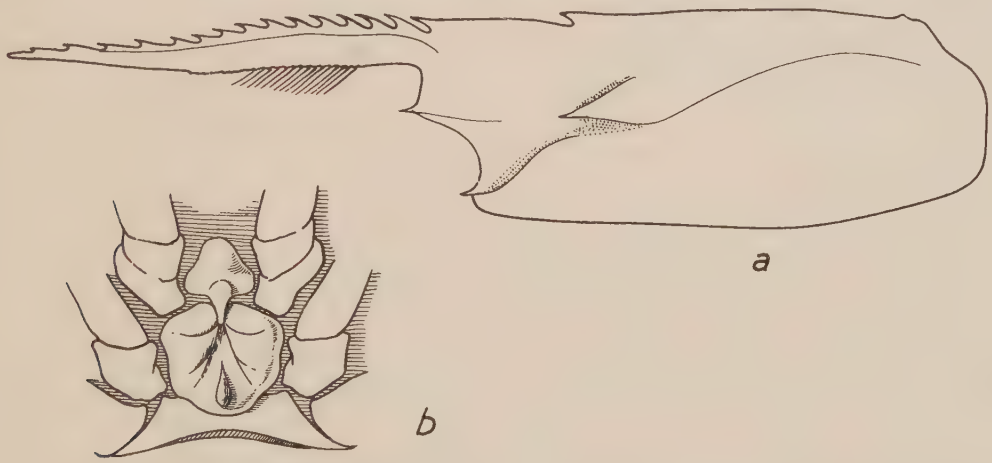
Distribution.—American Pacific region, North Atlantic region.

Penæopsis rectacutus (Spence Bate). (Text-fig. 12 *a*, *b*.)

Parapenæus rectacutus, Alcock, 1906, p. 33, pl. vi, figs. 19, 19*a* and *b*; Illus. Invest. Crust., pt. ix, 1901, pl. 49, fig. 5.
? Parapenæus rectacutus, De Man, 1911, p. 82.
Parapenæus rectacutus, Balss, 1925, p. 228.
Penæopsis rectacutus, Burkenroad, 1934*b*, p. 13.

Occurrence.—Sta. 16, Gulf of Aden, depth 186 m. ; 40 females, 20 males.

The largest specimen is 105 mm. All the specimens agree with the description and figures given by Alcock, except that the rostrum is not exactly straight ; there is a slight curvature in the middle of its length (Text-fig. 12 *a*). In the females the rostrum reaches the end of the antennular peduncle. The number of the rostral teeth varies from 10–14.



Text-fig. 12.—*Penæopsis rectacutus* (Bate). *a*, Carapace, × 3. *b*, Thelycum, × 5·3.

The ridge defining the anterior part of the cervical groove agrees exactly with Alcock's figure. The pterygostomian spine is placed higher than the antero-inferior angle of the carapace, which is almost square-shaped. The hepatic spine is almost at the same level as the antennal. In the majority of the specimens the telson carries three pairs of movable spinules, besides the fixed pair ; in one female it carries only one pair, and in two males and two females it carries two pairs. The 1st pair of legs is bispinose, and the 2nd pair is devoid of spinules in all the specimens. From the above and from the descriptions of Alcock and Balss, it appears that either two or three pairs of mobile spines may be present on the telson and that the 2nd leg may carry a spine or not ; these differences must therefore be attributed to intra-specific and not inter-specific variation. The thelycum agrees with the figure given by Alcock (1906, fig. 19 *b*—*vide* Text-fig. 12 *b*).

It would appear doubtful whether the specimens obtained by the " Siboga " and attributed by De Man to this species really belong to it, for De Man states that each lobe

of the petasma at its distal end is armed with a sharp spine ; such spines are not found in the type of this species, but are present in the type of *P. serratus* (see below under *P. serratus*). Unfortunately, De Man does not say anything about the shape of the thelycum.

Distribution.—Indo-Pacific region.

Penæopsis serratus (Spence Bate). (Text-fig. 13 *a–d.*)

Penæus serratus, Spence Bate, 1888, p. 268, pl. xxxvii, fig. 1.
? Penæopsis challengeri, De Man, 1911, p. 76.
Penæopsis serratus, Balss, 1925, p. 229, fig. 4 ; Burkenroad, 1934*b*, p. 13.

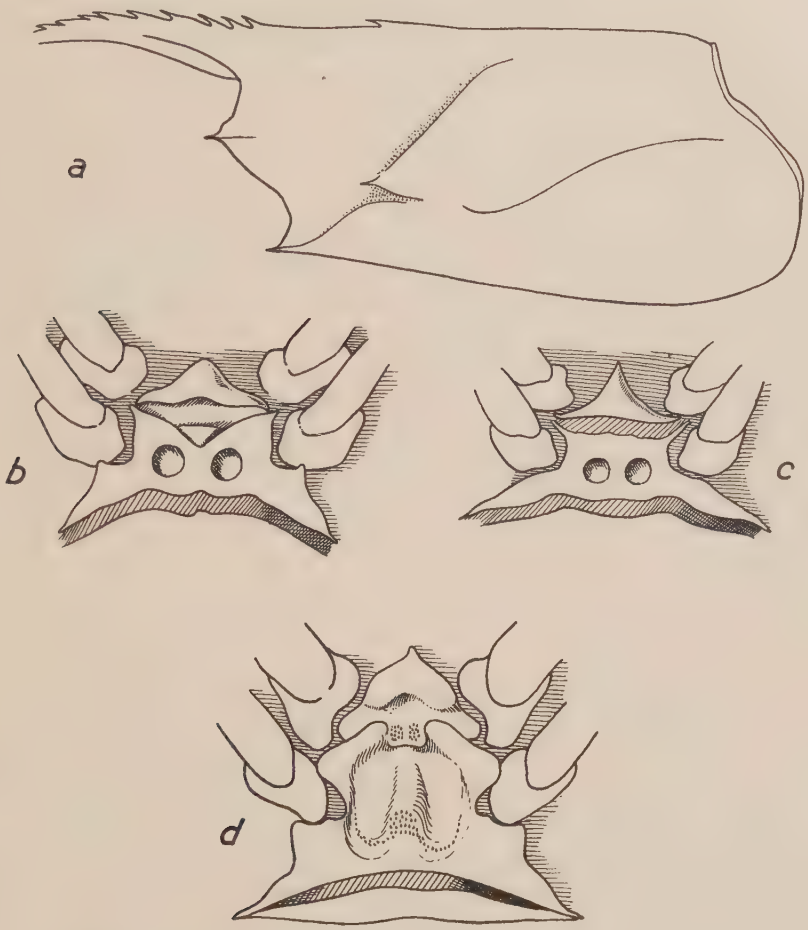
Occurrence.—(1) Sta. 105, Zanzibar area, depth 280 m. ; 17 females, 11 males.
(2) Sta. 107, Zanzibar area, depth 428–457 m. ; 1 female.
(3) Sta. 110, Zanzibar area, depth 347–384 m. ; 3 females.

The largest specimen is 115 mm. The rostrum is arched, carries 9–10 teeth, and reaches the end of the 1st segment of the antennular peduncle. The hepatic spine is placed at a lower level than the antennal and the anterior part of the cervical groove is oblique. The pterygostomian spine is placed just above the antero-inferior angle of the carapace, which is very rounded (compare Text-fig. 13 *a* with 12 *a* of *P. rectacutus*). The thelycum agrees with the figure given by Balss (1925). Although the thelycum of *P. rectacutus* and *P. serratus* are built on the same plan, yet on comparing specimens of the two species the difference is seen to be very marked (compare Text-figs. 13 *b* and 12 *d*).

During a visit to the Berlin Museum I examined the material of the German Deep-Sea Expedition that was identified by Balss as *P. serratus*, and found that the specimens are exactly similar in every detail to those taken by the John Murray Expedition. Whether De Man's *P. challengeri* is the same as that of Balss is not known ; Balss himself is uncertain. Spence Bate's species, however, seems to be different. Spence Bate's figure of the thelycum (1888, pl. 37, fig. 1‴) is completely different from the thelycum of both the large female described above and those of Balss. On examining the specimens from which Spence Bate's figure was drawn, it was seen that his figure of the thelycum is not very correct, but it is, at any rate, very different from the others. Again, the petasma of Spence Bate's specimen is different from the petasma of the males examined by Balss, for, as is shown by his figure and confirmed by my examination of the specimen, it is furnished distally on each side with an anteriorly-directed sharp slender process ; whereas in Balss's males the petasma is rounded anteriorly. Owing to these marked differences in the thelycum and petasma, it is with considerable reluctance that I have followed Balss and referred the specimen to *P. serratus*. If more material should be discovered later on in which the thelycum and petasma agree with Spence Bate's type of *P. serratus*, a new species will have to be established for Balss's specimen and for the specimen referred to above. It is not improbable that the male specimens referred by De Man to *P. rectacutus* are identical with Spence Bate's species. Burkenroad (1934, p. 13) states that no clear diagnostic distinction between *P. rectacutus* and *P. serratus* has ever been established. With regard to this I am of the opinion that there should be no question of the validity of *P. rectacutus* ; this species is easily separated by the shape of the rostrum, the shape of the anterior part of the cervical groove, the position of the hepatic spine in relation to the antennal one, the position of the pterygostomian spine

and the shape of the thelycum ; other differences, viz., the number of spines on the telson and the spinosity of the 2nd leg, must be regarded as intra-specific variations similar to those that, as I have pointed out, are found in *P. rectacutus*.

The specimens from Sta. 105 are young and the largest one of them is only 60 mm. in length. They are referred to this species on account of the position of the hepatic



Text-fig. 13.—*Penæopsis serratus* (Bate). *a*, Carapace, × 2·7. *b*, *c*, Central part of thelycum in two young females, × 8. *d*, Thelycum, × 5·3.

spine and the shape of the ridge defining the anterior part of the cervical groove. The thelycum in these smaller females is different from that in the adult. In Text-fig. 13 *b–d* I have given the outlines of three thelyca, showing different stages of development.

Distribution.—Indo-Pacific region.

Penæopsis (*Metapenæopsis*) *coniger* (Wood-Mason).

Metapenæus coniger, Alcock, 1906, p. 25, pl. iv, figs. 12, 12*a* and *b* ; Illus. Invest. Crust., pt. ix, 1901, pl. l, figs. 2, 2*a* and *b*.

See Calman, 1923, p. 536.

Occurrence.—(1) Sta. 16, Gulf of Aden, depth 186 m. ; 8 males.

(2) Sta. 70, Gulf of Oman, depth 196 m. ; 1 female, 1 male.

(3) Sta. 71, Gulf of Oman, depth 106 m. ; 8 males.

(4) Sta. 75, Gulf of Oman, depth 201 m. ; 1 female.

(5) Sta. 89, Northern area of Arabian Sea, depth 135–183 m. ; 1 male.

(6) Sta. 194, Gulf of Aden, depth 220 m. ; 13 females, 5 males.

While all the females can safely be referred to this species, it is with less certainty that the males are referred to it. The females of this species are easily distinguished from the females of *P. philipii* (Spence Bate) by the shape of the thelycum. Calman (1923, p. 539) writes : " I am inclined for the present to leave *P. coniger* apart as possibly a separate species, although I am unable to point to any distinctive characters except those of the thelycum." Alcock (1901) distinguished *P. coniger* from *P. philipii* by the relative length of petasma, which was said to be about one-third as long as the carapace in *P. coniger* and at least half as long in *P. philipii*. With regard to this distinction Calman writes : " In the specimens I have examined, it is at most much less marked than is implied in the earlier description." The examination of the abundant material of *P. philipii* obtained by the John Murray Expedition showed that, although the measurements as given by Alcock were not very exact, yet there is a noticeable difference between the relative measurements of the petasma in both species. In *P. coniger* it is either half as long as the carapace or less. In *P. philipii* it is invariably more than half as long as the carapace, the petasma being measured from the anterior part to the extreme end of the posterior prolongation and the carapace measured along the mid-dorsal line. The males from Stas. 70 and 71 have the petasma half as long as the carapace, while the males from Stas. 16, 89 and 194 have the petasma less than half the carapace. Exopodites are present on all the walking legs.

Distribution.—Indo-Pacific region.

Penæopsis (*Metapenæus*) *philipii* (Spence Bate).

Calman, 1923, p. 536, figs. 1, 2.

Occurrence.—(1) Sta. 105, Zanzibar area, depth 238–293 m. ; 2 females.

(2) Sta. 106, Zanzibar area, depth 183–894 m. ; 95 females, 142 males.

All the normal males have the petasma more than half as long as the carapace. Eleven males are parasitized with a Bopyrid parasite ; in these the petasma is much reduced, and the inner antennular flagellum lacks the concavity and the spine at the base, and thus resembles that of the female. Exopodites are present on all the legs. The thelycum exhibits wide variations, as has already been shown by Calman.

Distribution.—Indo-Pacific region.

Penæopsis (*Metapenæus*) *vaillanti* Nobili. (Text-fig. 14 *a–c*.)

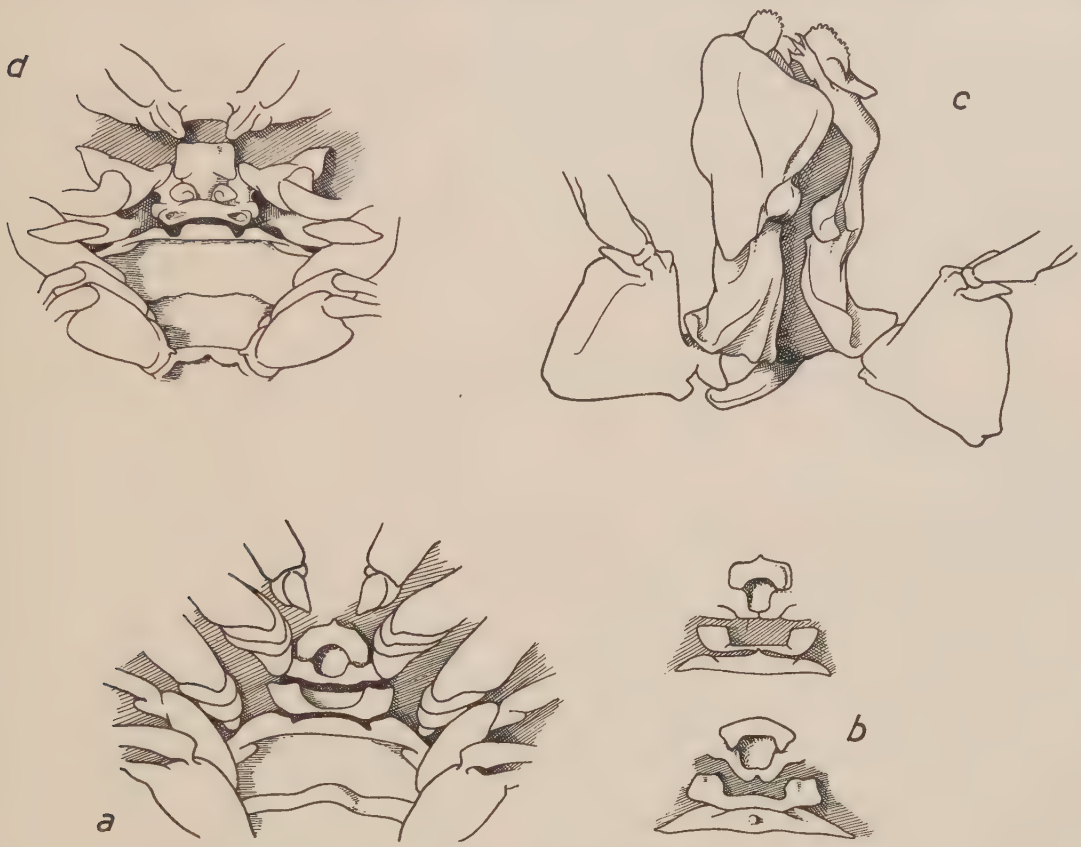
Penæopsis vaillanti Nobili, 1906, p. 18, pl. 1, fig. 4 ; Tattersall, 1921, p. 366, pl. 27, fig. 12.

Occurrence.—(1) Sta. 27, Gulf of Aden, depth 37–91 m. ; 1 female, 3 males.

(2) Sta. 80, South Arabian coast, depth 16–22 m. ; 7 females, 6 males.

In all the specimens the rostrum is straight and carries 6–7 teeth besides the epigastric one. The largest specimen taken (a female from Sta. 27) is 60 mm. in length. I have in front of me two large specimens (length 75 mm.) from the Red Sea. In these the lower edge of the rostrum is not straight, but is slightly convex. The rostrum reaches the middle of the 2nd segment of the antennular peduncle in the large specimen and in the two

specimens from the Red Sea ; in the smaller specimens it does not reach beyond the end of the 1st segment. The post-rostral carina does not extend beyond the gastric region. The antero-inferior angle of the carapace is produced as an acute tooth. The eyes are much wider than the eye-stalks. The 2nd abdominal segment carries a short carina in the middle part ; the 3rd to 6th segments are carinate, the carina of the 3rd being sulcate and that of the 6th ending acutely. The latter segment is about $1\frac{1}{2}$ times as long as the 5th, and is shorter than the telson, which is just shorter than the inner rami of the uropods. The telson carries one pair of immovable spines and three pairs of movable



Text-fig. 14.—*Penæopsis vaillanti* Nobili. *a*, Thelycum, × 6·7. *b*, Central part of thelycum in two smaller specimens. *c*, Petasma, × 13·3. *Penæopsis faouzii* n. sp. *d*, Thelycum, × 6·7.

ones. Exopodites are found on all the legs and epipodites on the first three. The 1st pair of legs carries a spine on both the basis and the ischium and the 2nd pair on the basis. In small specimens (length 35 mm.) the 3rd pair of maxillipeds reaches the end of the scaphocerite and the 3rd pair of legs is shorter than the external maxillipeds, and reaches beyond the antennular peduncle. In the large specimen from Sta. 27 and in the two specimens from the Red Sea, however, the legs are shorter than in the young, the external maxillipeds reaching only to the end of the 2nd segment of the peduncle, and the 3rd pair of legs to the end of the propodus of the external maxillipeds. The thelycum (Text-fig. 14 *a*, *b*) is composed of two plates between the 4th pair of legs and two between the 5th pair. The hindmost of these is cut into three lobes and the one in front of it is deeply concave anteriorly. The most anterior plate is oblique, neither

vertical nor horizontal; the one behind it is vertical, composed of two pieces, and is semicircular. The two anterior plates (those between the 4th pair of legs) enclose a more or less semicircular deep cavity. Between the 3rd pair of legs there is a pair of teeth and between the 2nd pair two spines. The coxæ of the 3rd and 4th legs are prolonged inward and the upper surface of each prolongation carries a sharply defined spherical cavity. The structure of the thelycum, however, is not constant (Text-fig. 14 *a*, *b*). The two plates between the 5th pair of legs may be widely separated from each other or may be so close as to give the impression of one plate, such as is the case with the thelycum figured by Tattersall. The two pieces which form the 2nd plate (between the 4th pair of legs) may be completely separated, or be partially or completely fused. The concavity between the two anterior plates may be circular or nearly so. The external piece of the right petasmal endopodite is large, but is shorter than the left external piece, which is slender and divided into three lobes anteriorly (Text-fig. 14 *c*). Nobili writes that this divided part is enclosed in a membrane, but I am unable to find this membrane in any of the males that I have examined.

Distribution.—Red Sea.

Penæopsis (*Metapenæus*) *faouzii* sp. nov. (Text-fig. 14 *d*.)

Occurrence.—Sta. 161, Maldive area, depth 46 m.; 2 females, each 50 mm. in length.

This species is closely related to *P. vaillanti*. The integument is thick, hard and tomentose. The rostrum is obliquely ascending, with both edges straight. It reaches the end of the 2nd segment of the antennular peduncle. In one specimen it carries eleven teeth and in the other nine besides the epigastric one. The post-rostral carina does not extend beyond the gastric region. The carapace carries a small orbital spine and a large antennal one, and the antero-inferior angle is prolonged into a large spine. The sub-hepatic groove, which resembles that figured by Alcock for *P. mogiensis*, is well developed. The pleura of the 1st abdominal segment overlap the end of the carapace. The 1st and 2nd segments are not carinate, the 3rd–6th are so. The carina on the 3rd segment is sulcate, those on the 4th–6th are sharp; on the 4th and 5th segments the carina is deeply cleft posteriorly and on the 6th it ends in a spine. The 5th segment is $\frac{3}{5}$ as long as the 6th, the latter being $\frac{2}{3}$ as high as long and shorter than the telson, which is almost as long as the uropods, and carries one pair of immovable spinules and three movable ones. The carapace is about half as long as the 6th abdominal segment. The external maxilliped reaches the end of the scaphocerite. The 3rd pair of legs reach the end of the 1st segment of the antennular peduncle. The thelycum (Text-fig. 14 *d*) consists of the following: a plate between the 5th pair of legs, which is cut into three lobes, as in other species; a plate between the 4th pair of legs, which is divided into two unequal parts; an anterior large part, with a concave upper surface and a small narrower one with a small rounded tubercle posteriorly on either side. Between these two plates there is a transverse plate with a concave posterior edge. There is a pair of sternal spines between the 3rd pair of legs. The thelycum differs from that of *P. mogiensis* by the absence of the divergent median teeth between the 4th pair of legs which characterize *P. mogiensis*, *P. distinctus* and *P. perlarum*.

Genus *Parapenæus* Smith.

Burkenroad, 1934*a*, p. 107.

In his redefinition of the genus Burkenroad (*loc. cit.*) writes, " a distal pair of fixed lateral teeth on the telson preceded by a pair of minute mobile spines "; and on p. 108 " Schmitt's statement that ' the telson of *Parapenæus* is without movable spines ' is incorrect ". Besides the species of *Parapenæus* collected by the John Murray Expedition, specimens of *P. longipes*, *P. investigatoris*, *P. fissurus* and *P. longirostris* were examined by me in the British Museum. In not a single specimen of this extensive material have I been able to detect the presence of mobile spinules. I have therefore consulted Dr. Burkenroad on this point, and he informs me that " the mobile spinules on the telson of *P. longirostris* is not constantly present, but is found in the majority of American specimens, as well as in the large examples from the Mediterranean available. . . . The occurrence of mobiles in the generic type was emphasized because the presence of a mobile armature in *Penæopsis* might otherwise have been granted great significance ". I would note also that the fixed spine which occurs on the inner edge of the ventral side of the basal segment of the antennular peduncle is minute in the material examined and much smaller than the corresponding ones in *Penæopsis*.

The species of *Parapenæus*, according to the definition of Burkenroad, are six: *P. longirostris* (Lucas), *P. americanus* Rathbun, which inhabit the Atlantic, the former occurring in the Mediterranean too, *P. longipes* Alcock, *P. investigatoris* Alcock & Anderson, *P. fissurus* (Spence Bate) and *P. murrayi* sp. nov., these last four species inhabiting the Indo-Pacific region.

Parapenæus fissurus (Spence Bate).

Parapenæus fissurus, Alcock, 1906, p. 31, pl. v, figs. 16, 16*a* and *b*.

Occurrence.—(1) Sta. 105, Zanzibar area, depth 238–293 m. ; 6 females, 2 males.

(2) Sta. 106, Zanzibar area, depth 183–194 m. ; 2 males.

In possessing a double curve the rostrum agrees with the description given by De Man (1911, p. 79). There are no epipodites on the 3rd legs, or movable spinules on the telson ; exopodites are present on all the legs, but those of the last three pairs are very minute. The spine on the inner edge of the ventral side of the basal segment of the antennular peduncle is very small.

Distribution.—Indo-Pacific region.

Parapenæus investigatoris Alcock & Anderson.

Parapenæus investigatoris, Alcock, 1906, p. 32, pl. vi, figs. 17, 17*a–c*.

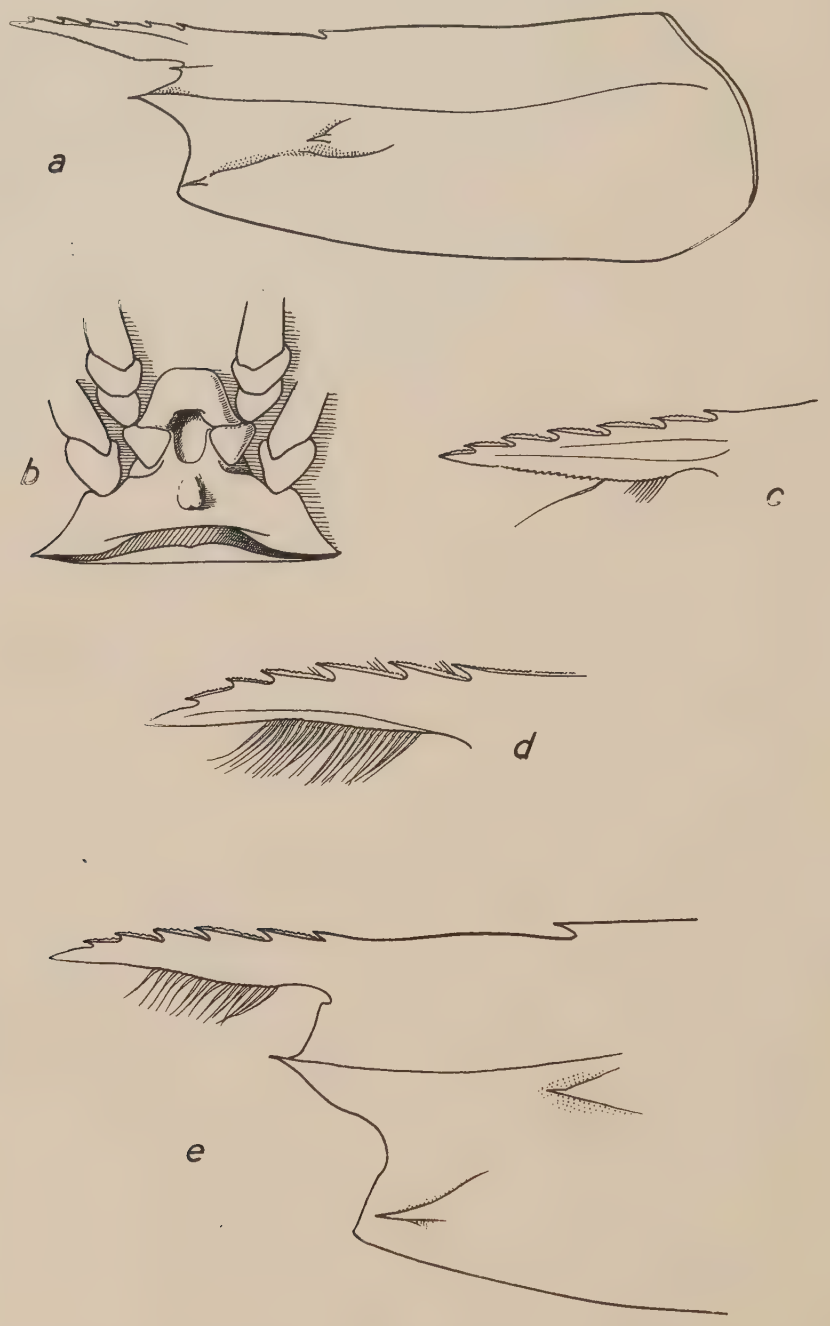
Occurrence.—Sta. 194, Gulf of Aden, depth 220 m. ; 14 females, 3 males.

The rostrum shows a distinct convexity, its tip being directed downward, and the ventral edge is distinctly concave. There are no epipodites on the 3rd legs, no exopodites on any of the legs, and no movable spinules on the telson.

Distribution.—Indo-Pacific region.

Parapenæus murrayi sp. nov. (Text-fig. 15 *a–c*.)

Occurrence.—Sta. 105, Zanzibar area, depth 238–293 m.; 18 females, 12 males. The largest specimen is 60 mm. long.



Text-fig. 15.—*Parapenæus murrayi* n. sp. *a*, Carapace, × 5·3. *b*, Thelycum. *c*, Rostrum, × 8·3. *Parapenæus investigatoris* Alcock & Anderson. *d*, Rostrum, × 10. *e*, Front of carapace, × 8·7.

This species is closely related to *P. investigatoris*, from which it is separated by a number of characters mentioned below. The rostrum (Text-fig. 15 *a*, *c*) is obliquely

ascending, with both edges straight. It carries six or seven teeth besides the epigastric one, and reaches to just beyond the eyes, but not to the end of the 1st segment of the antennular peduncle. The post-rostral carina stops abruptly at the middle of the carapace. A branchiostegal spine is present (above and behind the antero-inferior end of the carapace). The 1st pair of legs carries a spine on both the ischium and basis, no exopodites are present on any of the legs, and no epipodites on the last three pairs of legs. The 4th–6th abdominal segments are sharply and thinly carinate, each carina ending acutely; that of the 4th segment does not extend the whole length of the segment. The 6th abdominal segment is more than twice as long as the 5th, longer than the telson and just shorter than the carapace. The telson is much shorter than the inner rami of the uropods, and carries one pair of fixed spines but no movable ones.

The thelycum (Text-fig. 15 *b*) is built on the same plan as in *P. investigatoris*. The transverse semicircular plate between the 4th pair of legs in *P. investigatoris* is supported on two pillars, between which posteriorly is a tubercle and the whole organ encloses an 8-shaped fossa. In this species the two pillars unite posteriorly and carry a tubercle on that part. The 8-shaped fossa is absent. The petasma is completely similar to that of *P. investigatoris*.

This species is thus distinguished from *P. investigatoris* by the following characters:

1. The rostrum is obliquely ascending, with both edges straight, while in *P. investigatoris* (Text-fig. 15 *d*) it is convex. The post-rostral carina stops at the middle of the carapace, while in *P. investigatoris* it fades away in the posterior 4th of the carapace.

2. The 6th abdominal segment is, in comparison with the 5th, longer than it is in *P. investigatoris*. In the latter species it is equal to, or but little more than, twice the length of the 5th, and is much shorter than the carapace.

3. The structure of the thelycum differs in the two species, as described above.

Sub-family Eusicyoninæ Burkenroad.

Eusicyonia Stebbing.

Eusicyonia carinata (Olivier).

Sicyonia carinata, Milne-Edwards and Bouvier, 1909, p. 244; Balss, 1925, p. 232, fig. 8.
Sicyonia sculpta, Spence Bate, 1888, p. 294, pl. 43; De Man, 1911, p. 10.
For the rest of the synonymy, see Balss (*loc. cit.*).

Occurrence.—Sta. 106, Zanzibar area, depth 183–894 m.; 2 males.

Both examples were about 40 mm. in length.

LITERATURE.

Alcock, A. 1901. Descriptive Catalogue of the Indian Deep-sea Crustacea, Decapoda, Macrura and Anomala in the Indian Museum, Calcutta, pp. 1–286, 3 pls.

—— 1906. Catalogue of the Indian Decapod Crustacea in the Collection of the Indian Museum, Calcutta. Part III, Macrura. Fasc. I, The Prawns of the Peneus Group, pp. 1–55, 9 pls.

Balss, H. 1925. Macrura 2. Natantia. Teil A. Wiss. Ergebn. "Valdivia", XX, Jena, pp. 189-216, 2 pls., 16 figs.; 217–315, 9 pls., 75 figs.

Bate, C. Spence. 1881. On the Penæidæ. Ann. Nat. Hist. (5), VII, pp. 169–196, 2 pls.

—— 1888. Report on the Crustacea Macrura collected by H.M.S. "Challenger" during the years 1873–1876. Rep. "Challenger" Exped. Zoology, XXIV, London, 942 pp., 150 pls.

Borradaile, L. A. 1910. Penæidæ, Stenopidæ and Reptantia from the Western Indian Ocean. Trans. Linn. Soc. London, XIII, Pt. II, pp. 257–264, 1 pl.

Bouvier, E. L. 1908. Crustacés decapodes (Peneides) provenant des campagnes des yachts " Hirondelles " et " Princesse Alice " (1895–1915) Résult Camp. Sci. Monaco, XXXIII, pp. 1–122, 16 pls.

—— and Milne Edwards. 1909. See Milne Edwards.

Burkenroad, M. D. 1934*a*. The Penæidea of Louisiana, with a discussion of their World Relationships. Bull. Amer. Mus. Nat. Hist. LXVIII, 2, pp. 61–143, 15 text-figs.

—— 1934*b*. Littoral Penæidæ chiefly from the Bingham Oceanographic Collection. Bull. Bingham Oceanogr. Coll. IV, 7, 109 pp., 40 text-figs.

—— 1936. The Aristæinæ, Solenocerinæ and Pelagic Penæinæ of the Bingham Oceanographic Collection. Bull. Bingham Oceanogr. Coll., pp. 1–151, 71 text-figs.

Calman, W. T. 1923. Synonymy of a Penæid Prawn, *Penæopsis philipii* Bate. Ann. Mag. Nat. Hist. (9), XII, pp. 536–539, 2 figs.

—— 1925. On Macrurous Decapod Crustacea in South African Waters by the S.S. " Pickle ". Rep. Fish. Mar. Biol. Surv. S. Afr. IV, Special Rep. 3, Capetown, pp. 1–22, 4 pls.

Faxon, W. 1893. Report of Dredging Operations off the West Coast of Central America . . . during 1891. VI, Preliminary Descriptions of new Species of Crustacea. Bull. Mus. Comp. Zool., Harvard, XXIV, Art. 7, pp. 149–220.

—— 1895. Report of Explorations off the West Coast of Mexico, Central and South America and the Galapagos. XV, The Stalked-eyed Crustacea. Mem. Mus. Comp. Zool., Harvard, XVIII, pp. 5–292, pls. A–K, i–lvi.

Kemp, S., and Sewell, R. B. S. 1912. Notes on Decapoda in the Indian Museum. III, Species obtained by R.I.M.S.S. " Investigator " during the Survey Season 1910–11. Rec. Indian Mus. Calcutta, VII, 1, 2, pp. 15–32, 1 pl.

Lenz, H., and Strunck, K. 1914. Die Decapoden der Deutschen Südpolar-Expedition 1901–1903. I, Brachyuren und Macruren mit Ausschluss der Sergestiden. Deutsch. Südpolar-Exped., Berlin, XV (Zool. VII), 3 (6), pp. 257–345, 11 pls., 5 text-figs.

De Man, J. G. 1888. Bericht über die im indichen Archipel von Dr. J. Brock gesammelten Decapoden und Stomatopoden. Arch. Naturgesch., Berlin, Jahrgang. 5, pp. 215–600.

—— 1911. Decapoda of the Siboga Exped. Part I, Family Penæidæ. Siboga-Exped., Livr. 55, Monogr. XXXIX*a*, Leiden, 131 pp.

Milne-Edwards, A., and Bouvier, E. L. 1909. Report on the Results of Dredgings in the Gulf of Mexico . . . by the U.S. Coast Survey Steamer " Blake ". XLIV, Pénéides et Sténopides. Mem. Mus. Comp. Zool., Harvard, XLIII, pp. 181–274, 9 pls.

Nobili, C. 1906. Fauna Carcinologique de la Mer Rouge. Decapodes et Stomatopodes. Ann. Sci. Nat. (Zool.), IV, pp. 1–347, pls. i–xi.

Rathbun, M. J. 1906. The Brachyura and Macrura of the Hawaiian Islands. Washington, D.C., Bull. U.S. Fish Comm. 23, 1903 [1906] (827–930, pls. i–xxiv).

Schmitt, W. L. 1926. Crustacea Macrura (Peneidæ, Campylonotidæ, Pandalidæ) . . . Biol. Res. Fish. Exp. Aust. V, pt. 6, Sydney, pp. 311–381, 12 pls., maps.

—— 1935. The West American Species of Shrimps of the Genus *Penæus*. Proc. Biol. Soc. Washington, XLVIII, pp. 15–24, 2 pls.

Smith, S. I. 1886. On Some Genera and Species of Penæidæ, mostly from Dredgings of the U.S. Fish Commission. Proc. U.S. Nat. Mus. VIII (1885), pp. 170–190.

Sund, O. 1920. Penæides and Stenopides. Rep. Sars N. Atlantic Deep-sea Exped. III, 2, Zool. 36 pp., 2 pls., text-figs. and charts. (Republished 1932.)

Tattersall, W. M. 1921. Report on the Stomatopoda and Macrurous Decapoda . . . in the Sudanese Red Sea. J. Linn. Soc. Zool. London, XXXIV, pp. 345–398, 2 pls.

Wood Mason, J., and Alcock, A. 1891*a*. Natural History Notes from H.M.I.M.S.S. " Investigator " . . . No. 21. Notes on the Results of the Last Season's Deep-sea Dredgings. Ann. Mag. Nat. Hist. (6), VII, p. 38.

—— 1891*b*. Natural History Notes from H.M.I.M.S.S. " Investigator " . . . Series II, No. 1. On the Results of Deep-sea Dredging during the Season 1890–1891. Ann. Mag. Nat. Hist. (6), VIII, p. 32.

—— and others. 1892–1907. Illustrations Zoology " Investigator ", Crustacea, pts. i–xii.

Yokoya, Y. 1933. On the Distribution of Decapod Crustaceans Inhabiting the Continental Shelf around Japan. . . . J. Coll. Agric. Tokyo, XII, I, pp. 1–226, 71 text-figures.